THE GEOGRAPHICAL JOURNAL

Vol CXVII Part 1 March 1951

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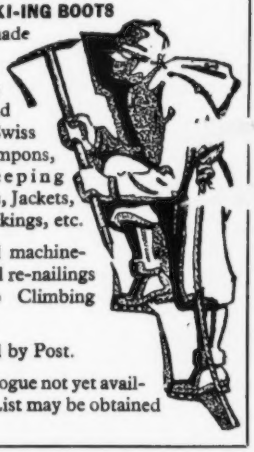

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NOTICES

PROGRAMME OF MEETINGS

Thursday March 8 *at* 5.30 *p.m.*
FILM MEETING FOR TEACHERS OF GEOGRAPHY

Monday March 12 *at* 5 *p.m.*
FINNISH KARELIA. *By W. R. Mead*

Monday March 19 *at* 8.15 *p.m.*
EXPLORATIONS IN THE NEPAL HIMALAYA. *By H. W. Tilman*

Monday April 2 *at* 5.30 *p.m.*
EXPLORING ROMAN CYRENAICA. *Kodachrome films with commentary by A. M. Frood*

Monday April 16 *at* 8.15 *p.m.*
RECENT ECONOMIC DEVELOPMENTS IN ISRAEL. *By Sir Clarmont Skrine*

Monday April 23 *at* 5 *p.m.*
HIGH MOUNTAIN PHYSIOGRAPHY AND PLANT GEOGRAPHY IN DIFFERENT CLIMATIC BELTS. *By Professor Carl Troll*

FESTIVAL OF BRITAIN—EXHIBITION AND LECTURES

AN EXHIBITION, "DEVELOPMENT OF BRITISH MAPS AND CHARTS," held in conjunction with the Institute of Navigation, will be open from May 3 for the period of the Festival.

Monday May 7 *at* 8.15 *p.m.*
THE BACKGROUND OF COLONIAL DEVELOPMENT. *By Brigadier M. Hotine*

Monday May 21 *at* 5.30 *p.m.*
FAMOUS FILMS OF BRITISH EXPLORATION
Details to be announced by card.

Monday May 28 *at* 5 *p.m.*
AN OXFORD EXPEDITION TO PERSIA. *By P. H. T. Beckett*

Monday June 4 *at* 8.15 *p.m.*
DANISH EXPLORATIONS IN CENTRAL ASIA. *By a member of the Danish Central Asian Expedition of* 1947–51

Monday June 11 *at* 5.30 *p.m.*
A YEAR IN FIJI. *Kodachrome films with a commentary by Dr. Telford Work*

Monday June 25 *at* 3 *p.m.* (*please note change of date*)
ANNUAL GENERAL MEETING

Proposals sent by Fellows to the Director and Secretary before May 25 will be taken into consideration by the Council in preparing the list of names to be submitted to the Annual General Meeting for election into the Council for the ensuing Session.

Light refreshments for Fellows and their guests will be served in the New Map Room after the Evening Meetings. Fellows are reminded that, unless special application is made, only one guest may be brought to Evening Meetings.

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The House of the Society is open from 9.30 a.m. to 5 p.m. on weekdays and from 9.30 a.m. to 1 p.m. only on Saturdays. The Library is also open for the exchange of books from 7.30 to 8 p.m. before Evening Meetings. The House will be closed for the Easter holiday from Friday March 23 to Monday March 26 inclusive, and on Whit Monday May 14.

The attention of Fellows is drawn to the fact that teas are now served in the Reception Room at the foot of the main staircase.

By Order of the Council, L. P. KIRWAN, *Director and Secretary*

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The
GEOGRAPHICAL JOURNAL

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HONG KONG: AN URBAN STUDY

R. H. HUGHES

IN THE Crown Colony of Hong Kong the sister cities of Victoria and Kowloon lie on either side of the harbour, sheltered on the north by the Kowloon Hills and on the south by the rocky spine of Hong Kong island itself. Within this area of 35 square miles, about half of which is water and another quarter steep hillside capable at best of supporting only a very sparse population, there live nearly two million people.

How the site came to be chosen a little more than one hundred years ago as the focus of South China trade; how it grew to become one of the world's largest ports and why, together with the immediate hinterland of the New Territories, it assumes such great importance at the present day may be seen in an examination of the geographical and historical environment. Such a study cannot ignore the human factors; Chinese industry, cheerfulness and commercial genius allied with British tenacity and administrative ability, which would have been capable of building a city in a hundred years anywhere on the coast of China from the Gulf of Tongking to the Sea of Japan. But those who chose the barren hills around the harbour of Hong Kong chose wisely, and it is doubtful whether the Anglo-Chinese effort would have been equally successful elsewhere.[1]

The meridian 114° 10′ E. and the parallel 22° 17′ N. cross in the middle of the harbour, which lies on the eastern side of the delta of the Canton river (Chu Kiang). It is midway between Singapore and Yokohama and near the direct sea and air routes between these two great ports, equidistant from the important islands of Hainan and Formosa, well situated athwart the Indo-China and China coast shipping routes and is the nearest harbour on the Asiatic continent to Manila. Yet these advantages are of minor importance compared with its enviable position with regard to the great inlet to Canton and South China. It is this which marks Hong Kong, and not Fuchow, Amoy, Swatow or Kwangchow-Wan, as the greatest port of the South China Sea,[2] for easterly winds make it impossible to maintain a deep-water anchorage on the Macao side of the estuary.

[1] E. J. Eitel thinks that the people on the spot did not choose the site at Hong Kong in 1841 but accepted it unwillingly. See 'Europe in China,' 1895, p. 124.

[2] "Prior to our taking possession of Hong Kong, and for some time after, all the native traders between Canton and the East Coast passed through the harbour and generally anchored there." Eitel, *op. cit.*, p. 169.

Relief, climate and communications

The topography of the urban area on both sides of the harbour is one of strong relief, based with one exception on granite and related rocks.[1] This exception is the high ridge which includes Mount Davis, the upper part of Kennedy Town and the middle levels and hill district of Victoria and which is composed of older (Mesozoic) volcanic rocks comprising nearly every type of volcanic product. The tuffs weather to light-coloured silty clay soils and the lavas to brown silty loams; except for scrub on the sides of ravines they support little but coarse grass. The local granite varies widely in colour, constitution and other properties. It occurs in massive intrusions and is usually

Fig. 1. Hong Kong and its environment

a well-jointed, hard, grey or pink, coarse-grained rock when fresh. It weathers to a soft mottled red and buff rock composed of quartz grains in clay which is often lateritic. In places, notably at Cha Kwo Ling opposite Quarry Bay, the felspars weather to fine white china clay. Large residual boulders remain and these supply excellent building and roadstone, for the heavy over-burden of the native rock has frequently made deep quarrying less economical. The decomposed granite forms a subsoil which is frequently very deep and which gives rise to a buff-coloured gritty or coarse sandy loam which supports

[1] For the geology of the colony, see two papers by M. Y. Williams *et al.* "The stratigraphy and palaeontology of Hong Kong and the New Territories," *Trans. Roy. Soc. Canada* 3rd Ser. 37 (1943) and "The physiography and igneous geology of Hong Kong and the New Territories," *Trans. Roy. Soc. Canada* 3rd Ser. 39 (1945). A geological map of the colony is in preparation.

coarse grass and, in ravines, low scrub. In its natural state the hilly terrain is strewn with rounded boulders and in places is almost bare of vegetation; the low foothills of Victoria, notably those of the Tai Hang, North Point and Quarry Bay areas, and the hills of Kowloon below the 500-foot contour, are largely of decomposed granite, so heavily gullied and denuded of topsoil and vegetation as to form "badland" areas. These "badlands" have increased since 1939 with the cutting of timber during the Japanese occupation of the colony. There are signs that the erosion is now being checked, but only a properly engineered process of reclamation with resurfacing and replanting will establish a vegetation cover in these areas. As many of them are cemeteries or are nearly ripe for development such reclamation is not economical, and a considerable part of the town has a very barren appearance. On level spots among these low hills wherever sufficient water is available are to be found, often in close juxtaposition to built-up areas, the market-gardens and nurseries which supply part of the cities' needs in flowers and vegetables.

A submerged coastline, which on this side of the Canton delta has experienced only slight sedimentation, provides little in the way of coastal flats. When Victoria was founded such flats existed only in very sheltered inlets, such as those in the Happy Valley–Tai Hang area and in small areas around Kowloon Bay. Any other level ground around the harbour is the result of man's activities. The tidal scour which helps to prevent the formation of coastal flats, also keeps the deep-water harbour relatively free from silt and pollution and enables the two cities to dispense with any sewage disposal works, beyond the organizing of night-soil coolies and lighters and the provision of sewers discharging into the harbour.

Hong Kong lies on the margin of the great Asiatic monsoon and has hot humid summers and cool dry winters, but the so-called "south-west monsoon" is not so regular or uninterrupted, nor is the winter so completely dry, as in the true monsoon countries. In 1948, which was a slightly wetter year than normal, the prevailing direction of the wind was between north and east for eleven months of the year and from the south-south-west in July only. The general tendency of the weather from May to September is however from the south, although winds may be variable; temperatures are high, night and day, but do not often rise above 90° F. Out of a yearly average rainfall of 84 inches, 65 inches fall during this period, mostly in heavy showers or in sustained downpours associated with intense tropical depressions or typhoons. There is no month in the year during which a typhoon has not been recorded in the colony, but they are most common in the summer and autumn. Winds of hurricane force occur when the centre of a typhoon passes over or near the colony, and these have had to be taken into account in planning buildings and port works; several days' outdoor work, particularly in the harbour, are lost every year because of adverse weather conditions. From October to February, winds are from the north-eastern quadrant and fairly steady. Humidity and rainfall are low and temperatures range from 40° F. to 85° F. In the transition period in March and April the weather is frequently overcast and fog and mist may interfere with shipping and aircraft.

Hong Kong is well served with external communications. In normal times (though it is said of Hong Kong that times have never been normal since its

foundation) ocean-going ships of every flag and every tonnage bring goods for transhipment in such volume that it is the greatest entrepôt in the South China Sea, if not in the Far East. The colony is in direct contact not only with its near neighbours but with every major country of the world, by air as well as by sea. Land transport to the New Territories is by good all-weather motor-roads, with dubious connections through Shum Chun into southern Kwangtung. More reliable when not threatened by war is the Kowloon–Canton railway connecting with the Canton–Hankow railway.

The story of Hong Kong is largely the story of its port and the associated financial and commercial undertakings. Even though it is now becoming to some extent a manufacturing centre, it is likely that most of its inhabitants will continue to be employed in commerce and distribution; this is the more likely now that the emphasis is on far eastern trade in general rather than on trade with South China. Internal consumption accounts for probably a tenth of the total goods imported; the colony must remain an entrepôt or diminish greatly in importance.

The naturally excellent harbour is improved by good wharfs, buoyed anchorages and well-organized facilities for weather forecasting; and an adequate supply of labour, lighterage and storage ensure a high rate of loading and discharging cargo. Pilferage is low. Before the Second World War many ships were attracted to Hong Kong by the excellent repair facilities, which were cheaper than in most ports in the world. Even now that the comparative cheapness no longer exists, shipping is still attracted owing to the scarcity of facilities elsewhere.

The history of the colony

The Portuguese came to Macao, the spearhead of European adventure in the China Sea, from Malacca and the East India Company established a post there in 1664. In 1771 they opened a trading factory in Canton itself. Other nations followed them and, as the monopoly of "the Company" was broken, other British traders came too. Trade was precarious and depended very much on relations with the Chinese Viceroy in Canton. The navigation of the river up to Whampoa and Canton was hazardous and relied on the good will of Chinese pilots. When therefore the import into Macao and Canton of opium, their most valuable cargo, was prohibited in 1821, British merchants and shipowners were not entirely sorry to make use of the anchorages around the Lintin, Lan Tao and Hong Kong islands.[1]

The first anchorage was off Lintin island where depots were established ashore (the foundations of which may still be seen) but the anchorage was not safe in all weathers and by 1836 ships were using Hong Kong more and more frequently. In 1839, after a series of indignities perhaps not entirely unmerited, the final breach came and Captain C. Elliot, the Superintendent of Trade, ordered all British subjects to leave Canton; in the same year they had to leave Macao also and sought asylum in the ships in Hong Kong harbour. In 1841, they settled peacefully on Hong Kong island itself, which was then

[1] Hong Kong (Heung Kong) was originally the name given by fishermen to the harbour of Aberdeen on the south side of the island; this attracted ships because of the stream of sweet water which entered the sea at Waterfall Bay nearby. Europeans later applied the name to the whole island and the main harbour.

a haunt of smugglers and pirates and inhabited by a few farmers, fishermen and stonemasons. "Stern necessity and not their wills sent them thither. The same necessity ordained that the little band, once lodged there, should take root, and growth followed as a natural result of the inherent vitality of the organism."[1] A most decisive feature, and the reason for the phenomenally rapid growth of the city of Victoria in the early days, was the arrival as going concerns of large sections of the British commercial communities from Canton and Macao.[2]

The transfer of sovereignty from China to Britain was a protracted process, but in August 1842 the Treaty of Nanking confirmed the transfer of the island to Great Britain.[3] By the Convention of Peking in 1860, the British Crown obtained a lease of the Kowloon peninsula, south of what is now Boundary Street. The following year saw this peninsula, together with Stonecutters Island in the harbour, ceded outright. In 1898 under a second Convention of Peking the remainder of Kowloon (New Kowloon) and the New Territories, including all the northern shores of the harbour and the land south of the Kowloon hills, were leased to Britain for a period of ninety-nine years. Whatever storms have swept over China since, with the exception of the Japanese occupation, the British Crown Colony of Hong Kong has remained the one stable point. The Japanese occupied the colony from December 1941 to September 1945. The fighting in 1941 though heavy, did not in itself cause more material damage than could have been repaired in a few months; greater damage was caused by looting at the times of occupation and reoccupation and by allied bombing in between, so that by 1946 European housing for 7000 persons and Chinese housing for 160,000 was uninhabitable; factories were largely denuded of machinery, port and shipyard facilities seriously impaired and more than half of the pre-war population was scattered. The only substantial improvement carried out by the Japanese was the extension and reconstruction of Kai Tak airport.

The settlements of Victoria and Kowloon have grown through various turns of fortune from the first thirty-three lots with sea frontages, sold by Captain Elliot on 14 June 1841, to the haphazard and overcrowded cities that they are to-day. Up to 1845 the settlement was an intermittent 2-mile strip between Queen's Road and the sea, extending in the first stage almost continuously from Possession Point to Morrison Hill. It was at no place more

[1] Alex. Michie, 'The Englishman in China,' as quoted by James Orange in 'The Chater Collection,' 1924, p. 326.

[2] For the history of the colony, see G. R. Sayer, 'Hong Kong 1841–1862,' 1937; E. J. Eitel, 'Europe in China: the history of Hong Kong from the beginning to year 1882,' 1895; and W. A. Wood, 'A brief history of Hong Kong,' 1940 (the last is an outline of the history to 1938). Since this paper was written in 1949, S. G. Davis has published his 'Hong Kong in its geographical setting' (London, Collins, 1949; reviewed in *Geogr. J.* 115 (1950) 106). This excellent book contains a full bibliography of the whole subject of the colony and its relationship to its hinterland.

[3] Treaty of Nanking, Article III. ". . . it being obviously necessary and desirable that British subjects should have some port whereat they may careen and refit their ships, when required, and keep stores for that purpose. . . ." It is possible that the future of Hong Kong as Britain's entrepôt in South China was already realized, but it may not have been considered diplomatic to reveal intentions too fully in the text of the treaty.

than 150 yards wide, being bounded on the northern side by low sea-walls along the shore.[1] There was also some settlement in the Happy Valley area (though this was not popular in the early days for fear of fever and pestilence) and at East Point and West Point. The south side of Queen's Road rose steeply along almost its whole length, as the stepped streets still bear witness, and on these slopes were scattered a few military, administrative and institutional buildings. The dense mass of Chinese residential and commercial settlement, which to-day stretches unbroken from the city centre to Sai Ying Poon with scattered outliers at either end, began in two small areas between Wellington Street and Queen's Road and in the area below Blake Gardens.

The urban site

The natural site of Victoria was completely built over in the first few years and there the boundaries would have remained but for the pressure of trade

Fig. 2. Victoria: the new coastline of reclaimed land superimposed on the map of 1845

and population. The only outlet was out to sea and up the hill, and thus began a long series of reclamations. Many of these were costly and there have been cases where the cost of forming a site has been greater than that of the building erected on it, but land was valuable and well repaid the capital outlay. By 1862 seaward reclamations to the approximate line of Des Voeux Road, Ko Shing Street and Johnston Road had been completed.[2] In 1893 the waterfront from West Point to the Naval Yard was substantially as it is to-day. Before the First World War, further reclamations had been made to the east and west of the town, while the 4,000,000 square feet Praya East reclamation, on which stands the homogeneous urban unit of New Wan Chai, was undertaken between 1920 and 1929. Further reclamations from the harbour are planned or underway at several points along the water-front; their feasibility will depend very largely on labour costs relative to the value of the reclaimed land.

[1] The north-eastern shore of the harbour, from Kai Tak to Lye Mun, with its few narrow coastal flats and its narrow silted bays backed by steep hills presents an illustration of Victoria as it must have been in 1841. But here too, development is now in progress.

[2] It was alleged in 1855 that 298,685 square feet had been reclaimed privately by owners of marine lots in opposition to the rights of the Crown. Eitel, *op. cit.*, p. 328.

From the early days the British and Portuguese, who together form the bulk of the "foreign" community, realized the advantages to health of living away from the lower levels of the city and, though the Military and the junior members of the foreign firms usually lived in messes or above their offices, they developed what are now the "Mid Levels," the northern slopes of the Victoria Peak group of hills between the 200- and the 900-foot contours. The growth appears to have commenced at about the Bonham Road, Caine Road, Kennedy Road level and to have crept up the hill, urged on partly by the increase of the foreign community itself and partly by the press of more fortunate Chinese citizens who, in turn, began to appreciate the advantages, both medical and social, of living here. The year 1874 saw the first permanent settlement in the hill district proper, locally called "the Peak," where, although the benefits of a 5° or 6° F. drop in the temperature were appreciated, they had been outweighed by the disadvantages of mist and bad communications. The construction of the Peak Tramway in 1888, and of two motor roads built between the wars, has speeded up the development of this beautiful district of dispersed residences. In the past it was almost entirely a European settlement but since the last war there are signs of it becoming increasingly cosmopolitan.

Apart from the Pok Fu Lam area it is only in the last twenty years that there has been any significant overspill of population to dormitory suburbs situated on the east and south sides of the island, but these settlements grew rapidly before the last war in the Shek O, Stanley, Repulse Bay, Deep Water Bay and Little Hong Kong districts and now constitute a serious threat to the unparalleled coastal scenery of the island.

The Kowloon peninsula is linked to central Victoria by ferries which ply between the Victoria termini and all parts of the harbour and the New Territories. A steady stream of freight-carrying craft, towed, powered or sailing, plies between the wharfs at Kowloon Point or ships lying at buoyed anchorages in the harbour, and the warehouses and coastal-shipping wharfs. These are situated along the greater part of the southern shore and, to a much less extent, around the Yau Ma Ti harbour of refuge and the light industrial areas of Sham Shui Po and To Kwa Wan. An electric passenger tramway runs almost the whole length of Victoria from Sau Ki Wan to Kennedy Town and has played a considerable part in the growth of working class suburbs at the extremities of the city, though the Chinese labourer, artisan or shop assistant usually lives within walking distance of his work if not actually on the premises. The Peak Tram, an electrically operated rope railway rising over 1200 feet in less than a mile, played a similar rôle in the development of the hill district, though it is now being superseded by the two motor roads which meet at Magazine Gap.

Most towns seem to have had a central artery from which they have grown, and in Victoria this is Queen's Road, narrow and tortuous by modern traffic standards but running through a city of far more narrow and more congested lanes, alleys and side streets. Kowloon has its north-to-south artery of Nathan Road, a much more imposing street and symptomatic of the more spacious layout of the younger city.

The development of Kowloon has not followed the same pattern as that of

Hong Kong. The levelling of sites is less difficult and from the first the rudiments of town-planning and the needs of the future seem not to have been lost sight of; it was probably always regarded as an overspill area for the older city. Historians have paid little attention to its development and the only stages which can be traced are the principal periods at which land was alienated to private persons, and the carrying out of public works.[1]

When the peninsula was ceded most of the land capable of irrigation was under cultivation.[2] By 1875 much of the area south of Jordan Road was privately held and developed for both residential and storage purposes, while the small reclamations and port facilities that line the tip and sheltered western side of the peninsula had been begun. About the same time a start was made on what is now the centre of Chinese commercial life around Shanghai Street and Yau Ma Ti; a smaller community developed around the new dockyard at Tai Kok Tsui in 1880.[3] The year 1864 saw the start of a dockyard venture at Hung Hom, with its associated community of work-people, but the main development in that area dates from twenty years later. The lease of the New Territories in 1898 produced little immediate expansion of Kowloon north of Boundary Street; the opening of the British section of the Kowloon–Canton Railway in 1910 caused minor residential districts to be developed in the New Territories, and Tai Po may now be considered a small dormitory suburb to Kowloon.[4]

The 1920's saw considerable reclamation on the sea front and low-lying agricultural land to form the modern Chinese suburbs of Sham Shui Po and Kowloon City—Kai Tak; the latter is partly occupied by the Colony's only airfield. Up to this time all development had been along the shore but a significant stage in the 1920's and 1930's was the building, to European town-planning standards of the time, of a residential district extending up the centre of the peninsula from Ho Mun Tin to the Kowloon foothills. The gaps in this belt, and in the pre-war industrial areas towards Lai Chi Kok and Ma Tau Kok, are being filled and an industrial suburb is growing up at Tsun Wan.[5]

Though reclamation has been less difficult than at Victoria, the expansion described above has been achieved only by removing several millions of tons of hard or decomposed granite, much of it by means of baskets and bamboo carrying-poles. And where it is not uncommon for more than 4 inches of rain to fall within an hour, any change in the natural fall of the ground creates problems in drainage and protection-works which if not heeded will undo the work of formation in a matter of months. Heavy retaining walls and wide and deep storm-water channels are a familiar feature of the urban scene.

[1] Most of these details are to be found in 'Historical and statistical abstract of the Colony of Hong Kong; 1841–1930,' Hong Kong, 1932.

[2] Collinson's map of 1845 includes the Kowloon peninsula, though not in great detail, and marks only Kowloon, Chimsa-tsui and Chowpae. What is now "Kowloon city," an area of less than 10 acres, includes the site of the old walled city and its immediate neighbourhood.

[3] E. J. Eitel, *op. cit.*, p. 565.

[4] This has not yet recovered from the devastation of the last war.

[5] The population of Kowloon rose from 123,000 in 1921 to 263,000 in 1931, and 581,000 in 1941.

Right in the centre of Kowloon, to the east of Ho Mun Tin, there is almost a square mile of bare unproductive hills rising at the highest point to 420 feet. Apart from the Chinese cemeteries which were closed before the last war in accordance with a decision to move all cemeteries out of the cities, its only use is to provide granite for building and roadstone and occasional filling for engineering projects; a few building sites have been formed but it remains an unsightly hindrance to the proper planning of the city. This hilly mass separates a Chinese area on the west, an area of large-scale industrial development on the east, and the European-style residential district to the north.

Buildings

At this point in the description of the growth of the urban area it may be profitable to insert a note on local architecture. Hong Kong lies just outside the West Pacific earthquake zone and the traditional building materials in the cities are the local granite, which varies in quality but at its best is an excellent building stone, and an unfired blue brick, much of which has been imported from the Canton delta. Recently these have been supplemented and almost supplanted by fired red bricks made at Castle Peak in the New Territories and by reinforced concrete; the cement is imported or manufactured in Kowloon partly from imported raw materials, the steel reinforcement is imported or rolled locally from old ships' plates. Until the advent of concrete all flat roofs were finished in foot-square Canton tiles, a lightly fired red tile about an inch thick, and the same tile was frequently used for flooring; the familiar roll and pantile Chinese ridge roofs were made almost entirely of imported tiles. China fir from the North or West Rivers, hardwoods from Malaysia and some woods from America are used. As elsewhere in China the ingenuity of temporary building has to be seen to be believed; given any waste material, animal, vegetable or mineral, from paper to petrol tins, the Chinese squatter will build himself a habitation.

With a diversity of modern materials to choose from, buildings are departing from the traditional style. With the pressure of population and the scarcity of land, and also because of the absence of serious earth tremors, it is natural that there should be a tendency to increase the height of buildings. This is noticeable not only in the commercial core of the city but also in the scattered residential areas where additional sites are difficult to find and many storied blocks of flats are replacing the spacious old colonial-style houses.

"Foreign" architecture, both domestic and commercial, was formerly inclined towards high and spacious rooms for coolness with deep verandas for protection against rain and sun. Now the tendency is to economize space, and air-conditioning is increasingly used. The modern trend in Chinese architecture is similar, but the old Chinese style deserves description because of its universality over the greater part of the city, and because modern styles are restricted by land tenure to a similar form. The maximum economic length of a China fir joist is 15 feet and the width of the average Chinese town or village house is limited by this dimension; hence the extremely regular appearance of the great majority of the streets in the Chinese areas of Victoria and Kowloon. Here rows of three- and four-storied houses have an identical

frontage, though the occupation of the houses may differ radically. The common unit of land tenure has become a 15-foot strip about 50 feet deep, and this size has been maintained in the modern reinforced concrete houses which are replacing the older properties.

Probably three-quarters of the Chinese families in Victoria and Kowloon are housed on a floor, or part of a floor, in a three- or four-storied tenement house.[1] Such a floor is 15 feet wide, 40 feet long and 12 feet high, and there may be in addition a 10 by 15-foot veranda overlooking the street in front and a small kitchen and toilet behind. More than half these floors are divided by wooden partitions into cubicles usually 8 feet square; each cubicle is occupied by a family, or family group, paying rent to a principal tenant who is frequently the occupant of one of the cubicles, and who makes a considerable profit on the rents. The veranda, kitchen and 6-foot wide passage extending the whole length of the floor are used communally, though spaces for beds in the passage may be rented to individuals or families. Overcrowding is thus a very pressing domestic and social problem.

All privately held land in the colony is leased from the Crown, on leases of 999 years' duration in the older parts of Victoria and from 75 to 150 years in the newer parts of the city, the remainder of Hong Kong island and the ceded territory of Kowloon. Crown leases in the New Territory part of Kowloon are for 99 years only, from 1898; land for temporary occupation is held from the Crown on annual tenancies. There is machinery to prevent the illegal occupation of Crown land, but in recent years a fringe of squatters has grown up around the built-up areas and, since the last war, in the devastated areas in the cities themselves. This is partly due to war damage in Hong Kong but chiefly to the influx of refugees from China. Rebuilding and vigorous action on the part of the health authorities have cleared the worst of the central areas, but the very large squatter colonies and the squalid temporary buildings on land legally restricted to agriculture are a major factor in the social geography of the colony.

Population of the colony

In Hong Kong, as in the cities of China, the abundance of human beings everywhere forcibly strikes the observer.[2] Figure 3 which shows the very rapid growth of population has been constructed from census figures and estimates, but in the past estimates have frequently tended to be high and should be treated with caution; as indeed should the census figures themselves, for they are difficult to collect with accuracy in all Eastern countries. The census data for 1921 and 1941 are not adequate for the compilation of population density maps, but Figure 4 illustrates the results of the 1931 census. The administrative regions upon which it is based are the city health districts though these are not ideal units. The maximum densities of 1254 persons to an acre in part of Victoria and 350 in part of Kowloon are a measure of the different degrees of congestion in the two cities, and may be compared with maximum densities of

[1] The situation is similar in Canton, and to a lesser degree in the newly built centres of other cities in Kwangtung province.

[2] Statistics in this section are taken from the report of the 1931 census of Hong Kong, and from Statistical Supplements to the Hong Kong *Government Gazette*.

about 240 to an acre in Rangoon[1] and 238 to an acre in London. It is doubtful if there has been any outward shift of population from central to outlying districts, but the growth of population since 1931 has resulted in increases in density on the south of the island, in the area of the Praya East reclamation in Wan Chai, in Wong Nei Chong and at North Point. In Kowloon, the density in the outlying districts has increased, particularly round Prince Edward Road and in all areas north of Boundary Street.

In 1948 a check was made of a block of 42 three-storied tenement houses

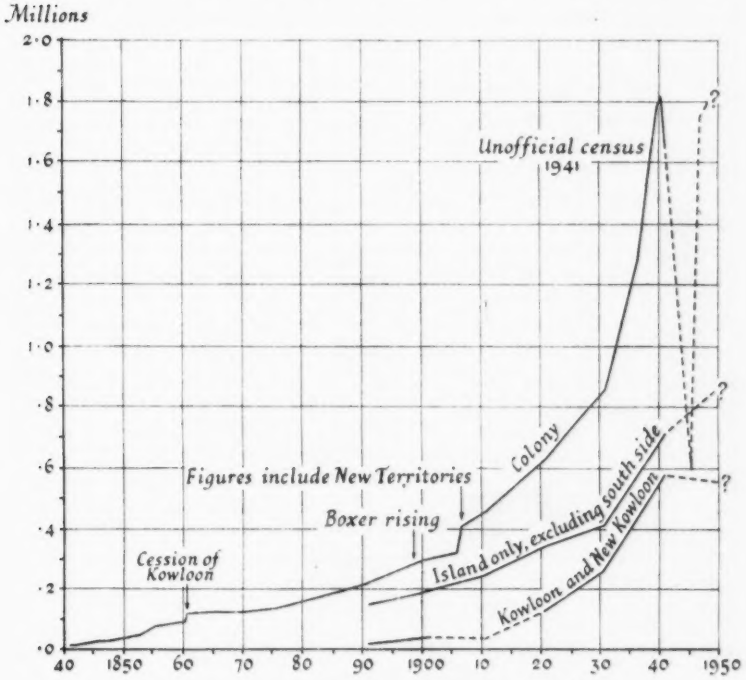

Fig. 3. The growth of population

in the central district of Victoria between Queen's Road, Des Voeux Road, Pottinger Street and Chinese Street. They had 2022 residents, an average of nearly 50 per house (or 17 per floor) including the ground floors which are nearly all used during the day as shops, workshops or warehouses. The 1931 census report gives an average of 39 persons per house in Health District No. 4, in which this block lies; in Health District No. 6A (the area around Bridges Street) however, the number of persons per house was then 54. Many houses in the latter area were destroyed during the war but in those

[1] O. H. K. Spate and L. W. Trueblood, "Rangoon: a study in urban geography," *Geogr. Rev.* 32 (1942) 64.

that remain this high density still occurs. There is reason to believe therefore that the density in the central areas of Victoria is at least as high as in 1931. Because of the increased numbers of buildings and the crowding within them, the densities in all districts of Kowloon, particularly in Health Districts 14 to 17, have probably increased considerably.

Of the total estimated population of the colony of 1,800,000 in 1949, it is estimated that there are 750,000 to 800,000 in the city of Victoria and the Peak, and 650,000 to 700,000 in Kowloon and New Kowloon.[1] In 1948 "the

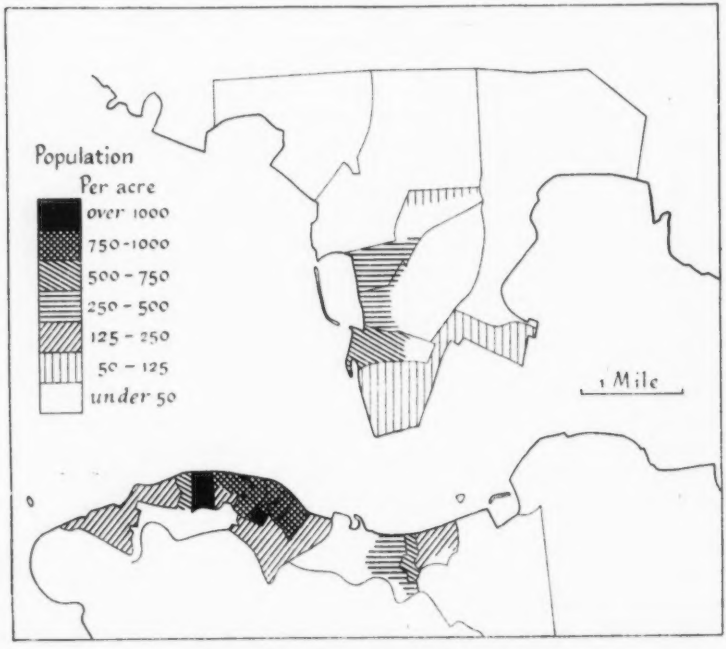

Fig. 4. Distribution of population, 1931

number of Europeans and Americans permanently resident, excluding service personnel and their dependents, increased to about 12,000. This total includes some 7000 British subjects from the United Kingdom and the Dominions, about 3000 British subjects of Portuguese race and 2037 aliens permanently resident. In addition there were some 1500 aliens temporarily

[1] The population of Victoria and the Peak is estimated at about 767,000 and of Kowloon and New Kowloon at 547,000, but these figures are difficult to reconcile with the total estimated population (*Hong Kong Annual Report* 1948, p. 17). The Air Raid Warden census in 1941 recorded 686,309 persons in Victoria and the Peak, and 581,043 in Kowloon and New Kowloon. The total population in these areas in 1951 is believed to exceed 2 million.

resident." [1] The number of Indians is about 2000. The chief racial groups among the aliens are as follows; fifty other nationalities are registered including only 2 Japanese:

Portuguese	983
Americans	802
Filipino	246
Dutch	221
French	180
Italian	176

A stable element of the Chinese population is the section that is Hong Kong born and bred; many would consider themselves British subjects [2] and some have gone to the length of obtaining British papers. A very large proportion of the Chinese population is migratory; the 1931 report states that of a total of 817,326 Chinese, 56 per cent. had been in the colony for 10 years and under, and 35 per cent. for 5 years and under; the corresponding percentages for non-Chinese are 65 per cent. and 47 per cent. respectively. Very few British or Americans are life-long residents of the colony.[3] The excess of males over females also points to the existence of a migratory population, but it is interesting to note that on the island the number of females per 1000 males rose from 571 in 1921 to 662 in 1931, and in Kowloon from 653 to 814, showing that the population is becoming a more settled one. The Chinese clings to associations with his native place more tenaciously than does the Englishman; his spiritual beliefs dictate it and the economics of his family life usually pre-suppose a regular remittance from all children who emigrate. In Hong Kong there are many clubs and mutual benefit societies, composed more often than not of people originating from one district of Kwangtung or the coast. At the Chinese New Year in January or February, and to a lesser degree at other festivals, there is an exodus of people "going home for the holidays." [4] No evidence of place of origin is available for the present Chinese population, but the figures in 1931 indicate the general trend. Condensed, they are given in the table overleaf.

[1] *Hong Kong Annual Report*, 1948, p. 16.

[2] In 1931, 2·3 per cent. ashore in Hong Kong and Kowloon; the percentage is much higher in the New Territories and among the population afloat.

[3] The 1931 census recorded 837 Eurasians but added that "most Eurasians are brought up as Chinese and would claim to be Chinese." At the present time there is among all classes of the population a considerable element of mixed blood which is not likely to be recorded in a census. The colony is little over a hundred years old and cannot yet be considered a melting pot of races; nevertheless there is a type of Eurasian not yet compacted into a class or society, a mixture of Chinese, Anglo-Saxon, and Portuguese in face and physique, whose language is a clipped, impure form of English usually spoken bilingually with Cantonese and whose mode of living and thinking is compounded of those of its ancestors. It may be the prototype of the typical Hong Kong man of the future.

[4] In 1948 there was an immigration and emigration, each of about 170,000 persons per month, by land, sea and air, apart from unrecorded arrivals and departures on foot or by small craft.

Place of birth	*Per cent.*
Hong Kong and New Territories	33
Canton Delta	46
Elsewhere in Kwangtung	19
Canton city (included in Delta)	6
Macao (included in Delta)	1
Elsewhere in China	1·5
Elsewhere in Asia	0·25
Outside Asia	0·15

The above figures are for the whole colony; of those living in Hong Kong island and Kowloon, 21·5 per cent. were born in the colony; of those afloat 75·1 per cent.; and of those living in the New Territories 89·3 per cent.[1]

It is believed that the present constitution of the Chinese population is substantially the same as in 1931, with the exception of a slight increase in the proportion from Shanghai and parts of northern China as a result of the war and the shift of certain industrial concerns from Shanghai to Hong Kong, but this increase may be only temporary and may be offset by increases from other parts of China.

In 1931 over 50 per cent. of the non-infant population of the two cities could read and write their mother tongue and over 6 per cent. could read and write English. With the intervention of war it is doubtful if these percentages have increased.

Of the 1931 population of 840,000 in the colony, 53 per cent. were occupied in the pursuit of gain, 71 per cent. of all males and 28 per cent. of all females. The proportion per 1000 of the occupied population engaged in various activities is shown in the accompanying table[2]: the figures for fishing and agriculture refer mainly to people outside the urban area.

Occupation	*Per mille.*
Commerce and finance	206
Manufacturing industries	191
Transport and communications	151
Personal services	130
Agriculture	89
Public administration and defence	50
Fishing	48
Building and decorating	45
Professions	21
Entertainment	14
Gas and electricity supply	4
Mines and quarries	4
Other categories	47
	1000

[1] These last two groups are composed of Cantonese (Tanka) and Hoklo afloat, and Cantonese, Hakka and Hoklo ashore in the New Territories. The population of the cities may however be taken as preponderantly Cantonese.

[2] This subject is very fully treated in the 1931 Census report from which the table is an abridgment.

Comparable figures are not available for the present population but, with some exceptions, the proportions are probably similar. Owing to the influx of refugees there is probably an increase in persons not regularly employed, yet this proportion is not so great as in 1940 when the number of refugees from Japanese occupied China was estimated at 750,000 out of a population of 1,822,000.

No data are available for the construction of a "social index" for Hong Kong such as that which Moscheles has drawn for Prague,[1] but it is perhaps of equal interest to plot the distribution of land values as an indication of the economic if not the social importance of the different zones of the city. This

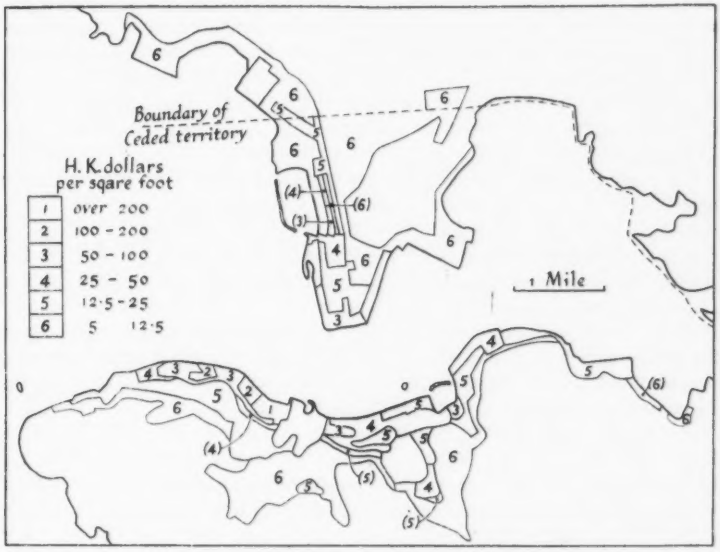

Fig. 5. Distribution of land values, 1948

has been done in Figure 5, though the assessments on which it is based are to some extent a matter of opinion. The writer has not seen this presentation used elsewhere and until similar maps have been constructed for other cities it is difficult to make comparisons.

The majority of industrial workers live near their work, but there is a daily ebb and flow of office and professional workers from residential suburbs to the business centre, as in any large city in Britain. Thus from the mid-levels, the Peak, the south side of Hong Kong island and from the peninsula and residential spine of Kowloon, broad streams converge on the central district of Victoria every morning. The cross-harbour ferries carry an average of 90,000 passengers a day, three times the pre-war number. The only other

[1] J. Moscheles, "The demographic, social and economic regions of Greater Prague: a contribution to urban geography," *Geogr. Rev.* 27 (1937) 414–39.

regular currents within the population are the holiday concentrations of crowds of all classes at sporting events, particularly racing and football, and in summer the week-end drift of the middle classes to the bathing beaches. Both these movements are more marked than they were before the war.

Food and water supplies

The New Territories produced 22,000 metric tons of rice in 1948, just over a month's supply for the colony. Much of it is of a very high grade and in normal years would have been exported, but now the export of rice is prohibited; the remainder of the colony's needs are met by allocations from Bangkok, Rangoon and Saigon, and on occasions from Egypt. Before the war four-fifths of the vegetables consumed were imported, but since the government set up a department of agriculture and opened a wholesale vegetable market it is claimed that "the fraction of home-grown vegetables (mostly from the New Territories mainland) is now probably nearer half the total consumption." [1] Imported fruit and vegetables come from the Delta, from Formosa and from Hainan and the Gulf of Tongking.

The colony's fishing fleets more than meet the demand for fresh, salt and dried fish. Pork is the principal meat food and comes mostly from the Delta, but the proportion from the New Territories is increasing. Cooking oil (usually ground-nut oil) used to come mainly from North China, but this source has now almost ceased. Large quantities of oil from all over the Far East pass through Hong Kong however and a sufficiency reaches the local market. Fresh milk is produced at Pok Fu Lam on the island, and beer at Sham Tseng beyond Tsun Wan on the mainland, but neither of these sources is adequate to meet the needs of the population, probably because of the increased consumption of both beverages by Chinese.

Apart from shallow wells which are now used mainly for flushing there is little underground water in the city areas, nor do the rivers have much dry season surplus over the needs of rice cultivation; the cities depend for their water supply on impounding reservoirs, fed by channels which intercept the run-off from adjacent hill-sides and valleys. The main reservoirs on the island are at Tai Tam, Aberdeen and Pok Fu Lam and have a capacity of 2362 million gallons. On the mainland the reservoirs at the western end of the Kowloon hills and at Shing Mun have a capacity of 3608 million gallons. Over 40 per cent. of the water used on the island comes by pipeline under the harbour from Kowloon. As the highest service reservoir is at a height of 1700 feet, pumping is necessary. The average consumption per head, of filtered and sterilized water, is nearly 20 gallons a day which must compare very favourably with towns and villages in China. In an urban district where the population has increased so rapidly it is not surprising that the water supply has seldom been able to keep pace with the full demand in the dry season. In the first half of the year restrictions are always necessary and, if the summer rains are long delayed or less than normal, the situation can become acute. A proposal to double the water supply of the colony by a scheme in the Tai Lam Chung valley, near Castle Peak in the New Territories, is under consideration.

[1] *Hong Kong Annual Report*, 1948, p. 54.

Hong Kong; Wing Lok Street on a quiet morning.

Victoria a hundred years ago

Hong Kong; the waterfront

Conclusion

Since 1945 nearly all the damage of the war years has been repaired and the progress of the colony has continued. Its population has been swollen once again by refugees from the civil war and economic severities in China, quite apart from the normal influx of political *émigrés* and destitute opportunists which is a regular feature of the life of the colony. The possibility of a continued increase in the population makes it profitable to examine the factors which control the continued spread and further development of the urban area.[1] The ultimate size, and to some extent the distribution, of the urban population will depend upon water supply and the end of new sources which can be developed economically by present methods is not very far off. If the present reservoir capacity can be trebled that will be about the limit. Nearly double the existing capacity together with additional distribution facilities is needed to give even the present population an unrestricted supply throughout the year. Thus the future number of permanent residents may be limited to about three millions.

The size and shape of the urban area will be determined by the land that can be made available at a reasonable cost for building purposes. In Kowloon the development of the more easily formed sites is proceeding apace, from Sham Shui Po to Lai Chi Kok; and at Ma Tau Kok for industrial purposes and along Boundary Street and Waterloo Road for residential purposes. With reasonable costs for labour, plant and transport, many of the remaining soft hills can be levelled for building and large reclamations made on both sides of the peninsula. The typhoon refuge at Yau Ma Ti could be filled to form building sites and a new refuge constructed elsewhere. The opening up of the north-east shore of the harbour from Kai Tak to Lye Mun is already under way at isolated points. A large area of comparatively level agricultural and squatter occupied land surrounds Kai Tak airport and, given space to settle the present occupants and money to carry out the necessary works, it would provide space for a suburb bigger than Sham Shui Po.[2]

As the residential districts of Victoria gradually climbed the hills, so in the future if population pressure is sufficient, a wave of residences may clothe the lower slopes of the Kowloon hills. Satellites or new towns are possible at Tsun Wan and around the head of the Sha Tin inlet and possibly at Hebe Haven. The site at Tsun Wan is already under way though its future character is not yet clear.

The development of the urban area of the peninsula outside Kowloon will be influenced by the expiry of the New Territories lease, due in 1997. This event already enters into the calculations of property owners in the Colony and after 1970 may be expected to have a marked effect on development beyond Boundary Street

The urban area of Victoria is almost saturated except for a strip of residential and industrial development now going on between North Point and

[1] Sir Patrick Abercrombie has drawn up an outline plan for the development of the urban area which is being examined by the authorities.

[2] Were Kai Tak airport ever to become obsolete, the space available for development would be doubled and the engineering problems made easier.

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HONG KONG
LAND USE 1949
Houses and tenements
Shops, public buildings and hotels
Warehouses and oil installations
Industrial and railway premises
Military and naval establishments
Dispersed residences
Parks and open spaces
Agricultural land
Areas occupied by squatters
Kowloon City
Kai Tak
Air Port
Sai Kung
8 miles
Waterloo Rd.
S Kowloon
Bay
Argyle St.
Ho Mun Tin
Ma Tau Kok
To Kwa Wan
KOWLOON
Kings Park
Hung Hom
Chatham Rd
Kun Tong
Cha Kwo Ling
HARBOUR
Tsim Sha Tsui
North Point
Quarry Bay
Lye Mun
Morrison Hill
East Point
Causeway Bay
Sai Wan Ho
Sau Ki Wan
Tai Hang Village
Soo Kun Po
Happy Valley
Sai Wan Hill
640'
Wong Nei Chong
Mount Butler
1424'
Mount Parker
1729'
Jardine's Lookout
1414'
Mount Cameron
1424'
Mount Nicholson
1408'
Yards
500 0 1000 2000 3000
HUGHES

Quarry Bay, and new housing on the lower hill slopes on a line running from North Point nearly to Wong Nei Chong Gap. Scattered residential expansion is possible at great expense by opening new sites in the Hill District and on the south side of the island, or at lesser expense by increasing the density by building blocks of flats on existing sites. Both these processes are taking place slowly. The only other possibility for considerable expansion in the near future is the use for industrial, residential or recreational purposes of the low-lying strip of land to the east of Aberdeen.

The rebuilding of the greater part of the city to modern town planning standards will be an extremely protracted and difficult process because of the acute shortage of land and its high value, the very small units in which the greater part of the land is held, and because of the conservatism of land-owners. The opportunity has been taken to see that the rebuilding of war-damaged property conforms to the latest plan, but the problem of lowering the density or of introducing open spaces into the heavily populated areas has yet to be tackled.

The future growth of Hong Kong will depend as before on the relative freedom of world trade, on security and on the political and economic health of China. Without these, its advantages of geographical or demographical environment will be of little avail. With them, its disadvantages will be overcome successfully, as they have always been overcome in the past, by the fortunate blend of Chinese and British enterprise which still remains in the colony to-day.

APPENDIX

Land use in Hong Kong

Whatever his business and however prosperous, the traditional Chinese trader seems to be able to operate on a front of 15 feet, and this he still does over the greater part of Hong Kong. Only in the central districts of Victoria and on the tip of the Kowloon peninsula where the influence of the West is strongest is this practice departed from to any extent; here departmental stores and large shop and office blocks, often operated entirely on British or American lines, are common. Elsewhere, even where a large amount of space for storage or workshops is needed, the situation is usually met by the business encroaching on the living space of the family, or on upper floors, or frequently on to the pavement.

Most of the wholesale trade in the colony is carried on in offices, trade-associations or tea-shops, there being no wholesale commodity markets except those recently established for fish and vegetables. But as in the cities of the interior, and all the world over, perishable foods are sold as much in public as in the shops. Hawkers both licensed and unlicensed frequent every open space, particularly near the public markets, though they are kept on the move by official action.

In most Eastern cities merchants, bankers, manufacturers and the like tend to live at or adjacent to their places of business and they often house their work people upon the premises also. In Hong Kong, where overcrowding of all types of property is the rule, a land use map may give a wrong impression. Particularly in the large areas designated as Chinese tenements, there is a great mixture of activities, commercial, industrial and tenement residences being so closely intermingled as to be quite incapable of separation, except on a map

showing individual houses; and very few tenement houses are used for the same purpose on every floor. It is not uncommon to find a shop or workshop on the ground floor, a flat on the second and cubicles on the third. Figure 6 showing the use of ten houses in Des Voeux Road West in 1948 illustrates this.

Although the Chinese tenement house is the largest single category it is possible to distinguish regions which are relatively homogeneous in their land use, particularly if the ground floors only are considered. It is not within the scope of this paper to enlarge on the land utilization plan by describing each region independently, nor is any purpose achieved by trying to place boundaries

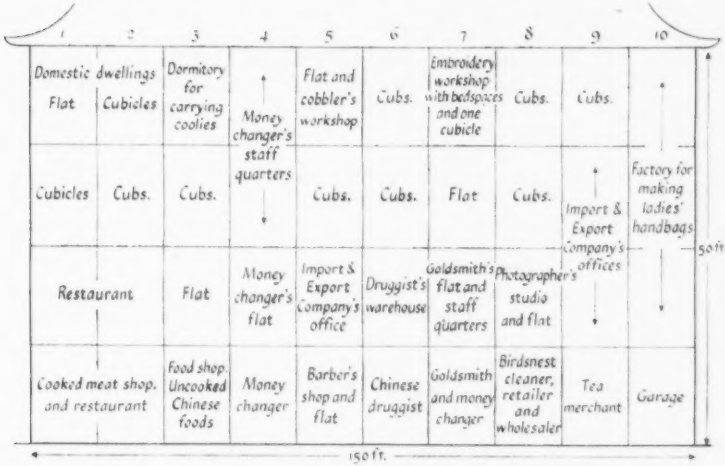


Fig. 6. The occupation of ten adjacent houses, 1948

where no real boundaries exist. Instead an attempt has been made, here and in the folding map accompanying the paper,[1] to draw profiles or cross-sections of the city, and to set down the trends which are noticeable along them.

Land use in Victoria

Section	*Block No.*	*Utilization*
A–A	1	Transit and storage *godowns* (warehouses); occasional houses on landward side.
	2	Smaller storage godowns and processing factories.
	3	Chinese middle class residential flats.
B–B	1	Godowns as in A–A 1; goods brought by lighter from ships or from Kowloon.
	2	Smaller storage godowns; some shops and living quarters on main road frontages.
	3	Residential and institutional—transition zone of urban fringe.
	4	University area.

[1] The map is based on a civic survey carried out in 1947 by the Town Planning Office of Public Works Department.

Section	*Block No.*	*Utilization*
C–C	1	Storage godowns. (Eastwards from this point the godowns become smaller and import and export business offices more numerous.)
	2	Centre of packing trades; tenement houses.
	3	Main dormitory area for godown labour of western district (now being rebuilt after war damage).
	4	Middle class flats and houses; some schools.
	5	Large residences of wealthy Chinese.
D–D	1	Import and export businesses and associated banking and shipping firms.[1]
	2	Mainly shops processing and marketing Chinese foodstuffs.
	3	Western limit of an area of Chinese workshops; tinsmiths, cabinet makers, tailors, printers, etc. The proportion of residences increases towards the south.
	4	Mission hospital.
	5	Middle class flats and houses. To the east the proportion of "foreign" residences increases.
E–E	1	Chinese import and export businesses with associated warehouses and living quarters; Chinese hotels and Western style department stores.
	2	Shops and offices; goldsmiths, money changers, brokers and agents. Overwhelmingly Chinese, but a zone of contact with Western style business.
	3	A war-devastated area now being rebuilt.
	4	Chinese and foreign residential area, with religious and educational institutions.
F–F	1	The heart of the colony's commerce and banking. To the west: European shops, restaurants, cinemas and hotels. To the east: naval, military and police establishments.[2]
	2	Administrative centre and Anglican cathedral.
	3	European residential area with large blocks of modern flats.
G–G	1	Shops, small restaurants and places of entertainment, catering largely for soldiers and sailors.
	2	Tenement houses over shops and workshops. A relic of the old "Canton bazaar."
	3	Mission school; residential flats (cosmopolitan).
	4	Blocks of flats. An area accessible to the city and enjoying the climatic advantages of moderate elevation.
H–H	1	Chinese tenement houses in reinforced concrete, built since 1920 on reclaimed land. Largely a dormitory area for all classes and more westernized than the older parts of the city.
	2	Tuberculosis hospital; and the older quarter of Wan Chai. Small workshops, marine stores and dealers in metal goods; street market.

[1] This block adjoins one of the oldest centres of Chinese life in the city; Bonham Strand East and Jervois Street stand on the first major reclamation completed before 1854.

[2] Here in an area of little more than 30 acres are to be found the business houses of all the great commercial undertakings, both foreign and Chinese; it constitutes one of the most concentrated sites of commercial enterprise in the colonial world.

Section	*Block No.*	*Utilization*
H–H	3	Small old style Chinese houses; some small iron foundries.
	4	Flats and houses (cosmopolitan).
I–I	1	Old godowns and spaces for open-air storage; modern block of cold storage warehouses.
	2	(Jardine's Bazaar) Carpenter's shops in temporary premises; an old general bazaar which is being rebuilt with tenement houses.
	3	Blocks of flats (a rapidly growing cosmopolitan residential area).
	4	Chinese philanthropical institution.
	5	Cosmopolital residential area (formerly British and Portuguese) overlooking racecourse.
	6	(Happy Valley).[1] Densely populated residential district (middle class Chinese).

To the east of section I–I the following districts deserve separate mention:

Soo Kun Poo—Recreation grounds and clubs.

Causeway Bay (west and south sides)—a rapidly growing hotel and entertainment area.[2]

Causeway Bay (east side)—A suburb with boat-building yards, biscuit and mineral water factories, oil installations, government stores and the power station.

North Point—A deep-water wharf with godowns now under construction (an earlier project was unsuccessful). Modern apartment houses on the foothills behind, now largely occupied by refugees from Shanghai and other Chinese ports.

Quarry Bay (Sai Wan Ho)—Sugar refinery (recently reopened) and shipyards with workers' dwellings. This suburb continues through junk-building yards and the fishing village of Sau Ki Wan to the harbour limit at Lye Mun.

Land use in Kowloon

In the matter of land use, the relationship of Kowloon and Victoria is not altogether unlike that of Birkenhead and Liverpool, or of London south and north of the Thames. While Victoria is largely devoted to overseas trade and distribution and possesses many of the signs of a metropolis, with insufficient living space for all who work there, Kowloon has far fewer offices, a greater proportion of residential to commercial buildings and more industries. Yau Ma Ti and Sham Shui Po are, if population is the criterion, considerable and almost self-sufficient Chinese sub-cities. There are more open spaces and these

[1] ". . . the Happy Valley was at first (1841) intended by British merchants for the principal business centre. However the prejudices of the Chinese merchants against the Fung shui (geomantic aspects) of the Happy Valley and the peculiarly malignant fever which emptied every European house in that neighbourhood almost as soon as it was tenanted caused the business settlement to move gradually westward." E. J. Eitel, 'Europe in China.' 1895, p. 167.

The geomantic principles to which Eitel refers are now reputed to be very favourable in the Happy Valley. For an account of geomancy see E. J. Eitel, 'Feng Shui,' Hong Kong, 1873.

[2] The urban district ends officially at Causeway Bay, but the boundary has now little administrative or physical significance.

are rarely left unused, either for agriculture, storage, or industries requiring open space or temporary building.

To the west of Nathan Road and north of Whitfield Barracks, and on the greater part of the east side of Nathan Road itself, there are hardly any buildings which do not conform to the Chinese tenement house pattern already described. The upper floors are almost entirely occupied by flats and cubicles and, to avoid repetition, only the use of the ground floors will be described.

Section	*Block No.*	*Utilization*
J–J	1	Wharfs and transit godowns for ocean shipping; some hostels for dock labour across Canton Road.
	2	Small Chinese residential area surrounded by shops catering for tourists.
	3	Flats, hotels and boarding houses (largely European).
	4	Railway property; part is temporarily used for recreation and other non-railway purposes.
K–K	1	Godowns.
	2	Shanghai Street, the main axis of Chinese life in Kowloon; shops of every description and, in the side streets, carpenters, metal workers, leather workers, etc.[1]
	3	Western type shops, hotels and cinemas.
	4	King's Park, the biggest single sports ground in the colony.
L–L	1	The Yau Ma Ti harbour of refuge for small craft; many boatmen use the harbour nightly. Sheds and yards for the storage of coal, timber, etc.
	2	Ships' chandlers, small engineering shops, etc., catering for the population afloat.[2]
	3	"Badland" area of erosion with patches of cultivation. Now being developed for European flats and school.
M–M	1	Small oil installation and several small shipyards.
	2	Light industry, often in temporary premises.
	3	Shanghai Street (see K–K 2).
	4	Similar to Shanghai Street but largely industrial and not yet fully built up.
	5	The edge of the Western style residential suburb which extends northwards to the foot of the Kowloon hills.
N–N	1	Chinese tenement houses built since 1920 (similar to H–H 1). Ground floors on main streets are shops; elsewhere used for light industry.
	2	An enclave of agricultural land surrounding two villages; not yet under urban development but becoming overrun with squatters.
O–O	1	Chinese shipyards (now giving place to factories).
	2	Houses and factories steadily encroaching on market gardens and squatters' plots.[3]

[1] Shanghai Street extends through sections K, L and M.

[2] The small tidal scour in the harbour of refuge prevents the introduction of water-borne sanitation in this block.

[3] The encroachment of houses and factories extends in a narrow strip to the official urban boundary at Lai Chi Kok where there is an oil installation and prison. The village of Tsun Wan, 3 miles distant, with an oil installation and modern engineering works, is also on the way to becoming an industrial centre.

Section	*Block No.*	*Utilization*
P–P		Railway workshops, wireless stations and, on the sea-front, the depot of the Sand Monopoly.
Q–Q		Dockyard, cement works, power station and workers' dwellings.[1]
R–R and S–S		A factory area, planned and built to modern standards before and after the last war. There is a fringe of gardens and workers' dwellings.
T–T	1	Residential, schools and open spaces.
	2	Tenement houses built since 1920. Occupants mainly engaged in weaving and dyeing trades.[2]
	3	An extensive and ever increasing "shanty town" of temporary buildings housing refugees and other persons displaced by the war. It is without roads, water supply, or adequate sanitation.

[1] The dockyard has been repaired since the war; the dwellings are still largely devastated.

[2] There were twice the present number of houses before the airport at Kai Tak was extended by the Japanese in 1943.

ELIZABETHAN GLOBES AT OXFORD

SIR EDMUND CRASTER

SO FAR AS is known, Merton was the first college in Oxford to provide itself with a pair of globes, the one celestial and the other terrestrial. Their acquisition—a curious transaction—is recorded in the college register under the date 10 December 1577 in the following terms:

"Ibidem consensum est de commutandis organis nostris et pro eisdem recipiendis duobus Globis a Mro. Smithe quondam huius Collegii socio. Alter erat coeli, alter terrae globus, cum eorum tabulatis capsulis seris ac clauibus."

How William Smith, rector of Cuxham and former Fellow of Merton, got his globes one cannot tell, nor yet guess at the motives that induced the college to barter organs for globes.[1] But so it was; the organ was taken down from its rood-loft in the chapel and removed, one may suppose, into Cuxham church and the new globes were placed under lock and key behind bars in wooden lockers. Probably they were of the type that Mercator originated in 1541–51, for Thomas Blundeville tells us in his 'Exercises' (1594) that Mercator's globes were in common use in England until 1592.[2] All that is known of the later history of the Merton globes is that they were lent in 1645 to the twelve-year-old Duke of York (afterwards James II), then resident at Christ Church.[3] Mr. Henderson, the college historian, gave a wrong date for their acquisition and was mistaken in saying that they were still in the college library.[4] The present pair are Senex globes made in 1740.

There is no evidence for the manufacture of globes in England before 1592. Towards the end of that year Emery Molyneux of Lambeth put a new type of globe upon the London market. He had been working upon it for some years, and at length produced it with the financial backing of a wealthy London merchant, William Sanderson. The date of production leaves no doubt that it was a pair of Molyneux globes which the energetic and enterprising Warden of All Souls, Dr. Robert Hovenden, set out to buy for his college in 1592–3.

The bursars' roll of accounts for that year give some interesting details regarding the purchase. First there is an entry of "xlviij s. v d. for Mr. Wardens bill for the globes & chamber rent ut patet per billam", from which it appears that Dr. Hovenden rode up to London to buy the globes and expended £2 8*s* 5*d*, though how much of that sum represents his hotel bill one can no longer say. But that was not the whole cost to the College. The account continues:

"viij^{s} to ye tanner for vj calfes skinns to cover the globes.
v^{s} to the basket maker for ij whicker basketes for the globes.

[1] Mr. H. W. Garrod points out to me that the college had tried to get rid of its organ ten years before, and may have bought a new one in the interval.
[2] Cited in E L. Stevenson, 'Terrestrial and celestial globes,' 1921, vol. 1, p. 132.
[3] Merton College Register, vol. 2, p. 365. I owe this reference to Mr. Garrod.
[4] Henderson, 'Merton College,' 1899, p. 212.

vj^{d} for makinge a scene (*i.e.* curtain) for one of ye globes.
vj^{s} to Dominicke[1] for coloringe vj skins for ye globes.
iiij^{s} to ye Corier for dressinge vj Calfes skins for ye globes after viij^{d} the skin.
ix^{s} ix^{d} for ix yeardes of Bayes to line the cases for ye Globes at xiij^{d} the yeard.
viij^{s} to ye Tanner for vij Calfes skins more for ye globes.
ix^{s} iiij^{d} to ye Corier for dressinge & coloringe of vij skins for ye globes after xvj^{d} the skinn.
viij^{s} to ye Sadler for makinge the lether cases for ye globes.
vj^{d} for mendinge the pinnes for one of the globes.
xviij^{d} for makinge ij pulleys & settinge them up in ye Chapel.
vj^{d} for paintinge the tops of the covers for ye globes."

This additional expenditure, amounting to £3 1*s* 1*d*, was due wholly to a decision taken to provide the globes with cases or covers, drawn up and down by pulleys, as a protection from dust or other injury. The sole earlier known instance of the provision of a canopy is that which the astronomer Tycho Brahe furnished for his great metal globe in 1584.[2] So its introduction at All Souls was evidently a novelty, and an expensive one at that. We learn from the various items of the college account that the globe cases were of calf skin, dressed and coloured and painted at the top; lined with baize and stretched on wicker frames. The decision to place the globes in the college chapel rather than in the library need not cause surprise. It was but a temporary measure, taken pending extensive alterations to the college library. Work on that room was in progress throughout 1597 and 1598, and in 1600–1601 the globes were re-erected in it. The Bursars' roll for that year contains the following entries:

"3^{s} for two payre of pulleys for the globes in the library.
10^{s} for gilding the pulleys of the globes in the library.
3^{s} to John Frenchman his son for mending the globes."

Warden Hovenden's globes had but a short life. Early in the seventeenth century, the College Benefactors' Book tells us, Dr. William Steede, who had been elected a Fellow in 1610, presented "two faire globes". The Adams globes now in the Codrington Library were given to the College by Dr. James Clitherow in 1750.

As a Fellow of Merton, although no longer resident in Oxford, Thomas Bodley must have been familiar with the globes which his college acquired in 1577; and so it happened that, when he refounded the University Library which has made his name so famous, he resolved that it too should have a pair of globes. No description has come down of this the first pair of globes that the Bodleian Library possessed. We can but guess that they also were by Molyneux. The little that we know of them is derived from the letters Sir Thomas wrote to his first librarian, Dr. Thomas James. Writing in one of

[1] "Dominicke" was Dominicke Pinart, an Oxford binder much employed by the college.
[2] Stevenson, *op. cit.*, p. 188.

them of the globes, he says, "They cost me very neere 20 li in regard of the extraordinarie guilding and limming that was bestowed upon them."[1] So gilt and so painted, they must have been very resplendent, and had some reason for costing near ten times the amount of All Souls' modest pair. But there was one thing about the All Souls' globes that Sir Thomas needed to know. They had just been re-erected in the college library, and in June, 1601, while his own library was still being furnished, Bodley wrote to his librarian to inquire "howe the globe case of Alsowels College is fashioned and howe it is drawen up and downe".[2] Sir Thomas was much given to detail, and was exercised over the length of his pulley ropes.

He was not long in regretting his expenditure. The globes were decidedly in the way, and Bodley was led to believe that very little use was made of them. In December 1608 he was writing to Dr. James, "I am persuaded there are not very many that would use the globes, and, if there were, I thinke within 3 or 4 yeres they would be so slurred as I should be forced to renewe them still, which would prove er be long a weerisom charge".[3] He reluctantly yielded to the representation "that many students are suitours to have the globes reserved",[4] but his fears that their upkeep would be a continuous charge proved justified. The Bodleian Library accounts record payments made to the joiner in 1629, in 1636, and again in 1644 for mending one or other of the globes; and with use the printed gores with which the spheres were covered must have become so smudged, or in Sir Thomas's phrase "slurred", as to be barely decipherable. In 1657 the Library was glad to receive from one Thomas Chaloner a new pair of Blaeu globes, described in the Bodleian Benefactors' Register as "globi duo, celestis unus, terrestris alter, editionis ultimae optimaeque Gulielmi Blaeu Amstelodamensis". In course of time, at some date after 1738, Chaloner's globes were in their turn discarded.

[1] G. W. Wheeler (Ed.), 'Letters of Sir Thomas Bodley to Thomas James,' 1926, p. 182.
[2] Wheeler, *op. cit.*, p. 8.
[3] Wheeler, *op. cit.*, p. 182.
[4] Wheeler, *op. cit.*, p. 183.

THE SPANISH CONQUEST OF MEXICO: SOME GEOGRAPHICAL ASPECTS

D. M. POOLE

ON 16 AUGUST 1519, Hernando Cortés struck west for the Aztec capital of Tenochtitlán. He had sunk the boats that brought him to Mexico [1] and his force contained only four hundred and fifty Spaniards. By battle, treachery and negotiation, the city was reached and Montezuma seized. But soon the Spaniards were beleaguered and on the disastrous *noche triste* had to flee from an outraged people. Finally came the savage and protracted assault in which the city was reduced to rubble and its inhabitants subdued. No sooner was this accomplished than Cortés and other conquistadores turned to conquer new peoples: the murderous Nuño de Guzmán pillaged the north-west, and Francisco de Montejo and his family began the conquest of Yucatán. Many others, soldiers, administrators and missionaries, helped to build the Catholic colony which by the end of the century covered so vast an area.

The story can however be viewed in a different light that but enhances its significance. Consider the conquistador, mounted on horseback and sword in hand. He was indeed a new figure in Mexico, where the horse on which he rode was as unknown as the cattle and donkeys that were soon to follow. Again, his steel sword which did so much to spread his power was a cutting instrument superior to any the Indian possessed. Its humble partners, iron axes and chisels, were soon replacing the Indian's stone, copper and bronze implements, and were cutting into the rocks and trees of his land. In brief, the Spaniard's conquest of the Indian was accompanied by new steps in man's conquest of the land (Plate 1). It is this second conquest which it is proposed to consider.

The Spanish innovations caused striking alterations in geographical values: they changed, for example, grassland into grazing. But their effect was more limited than one might suppose, and many pre-Cortesian features persisted into the colonial period. Although both conquest and new forms of land use brought about changes in population, the Indian survived to form the base of a colonial society that failed to use the full potentialities of the Old World innovations. In fact, to the meeting of two major culture streams in a land of unsurpassed variety may be attributed the immense diversity of the human geography of sixteenth-century Mexico.

Mexico in 1519

In Mexico there is a great variety of natural conditions (see Map).[2] The monotonous plain of Yucatán contrasts with the tormented relief of the

[1] "Mexico" is used throughout to mean the land to-day occupied by the Mexican Republic.

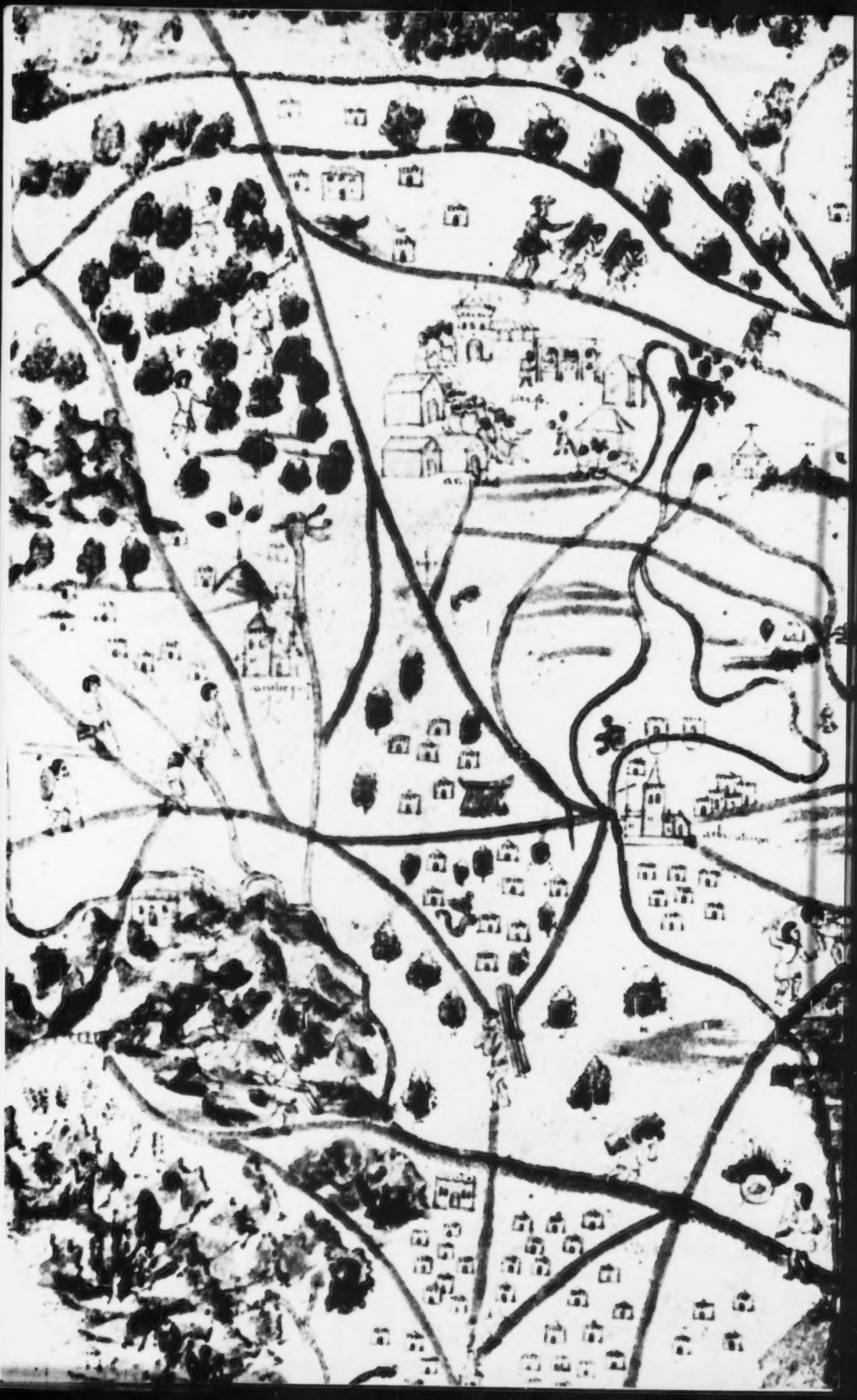
[2] The map accompanying this paper is simplified from M. O. de Mendizábal, 'Influencia de la sal en la distribución de los grupos indígenas de México,' Mexico, 1928 (summarized in '*XXIII International Congress of Americanists*, 1928,' 93–100). The map is necessarily somewhat schematic.

Sierra Madre Occidental, the level alluvial tract of the Valley of Mexico with the volcanoes that tower over it. A vast northern area is arid or semi-arid whilst the centre is better watered and parts of the south have a heavy rainfall. Differences of height give endless variety within these major contrasts In a matter of hours one can leave snow-capped peaks and plunge into lowland rain forest, or ascend from lowland desert into pine woods. More than half the country lies above 3000 feet, and the effects of altitude are sufficiently widespread and apparent to be recognized in popular speech. In the *tierra fría*, the so-called "cold" zone which lies above 6000 feet and is found mainly in the Mesa Central and the Mesa del Sur, the heat is never excessive, and mixed and coniferous forests are typical until the alpine meadows and the snow line are reached. Between 6000 and 2000 feet, the transitional *tierra templada* (literally, the "temperate" zone) leads down to the low-lying *tierra caliente*, the "hot" zone found mainly in the north-west lowlands, the Gulf coastal plain, the isthmus of Tehuantepec and the Yucatán peninsula. Here the heat is unmitigated and various types of tropical forest, ranging from selva to scrub forest, are typical. It is in tropical Mexico that these three zones present the most marked contrasts; towards the north, aridity tends to give a more uniform stamp to the country, and temperatures are more and more influenced by the widening mass of land and the stronger seasonal rhythm. The main significance of the mountains in the north is that some of them are high enough to gain an adequate rainfall. The Sierra Madre Occidental, for example, feeds streams flowing into the Mesa del Norte and the north-west lowlands which flank it on either side, and carries coniferous forests northwards between these lower and drier regions almost as far as the present international border.

Beside these strong contrasts of relief, climate and vegetation, must be placed equally marked variations in Indian culture. While some areas were occupied by savages, in others there were brilliant and original civilizations. South of a line from the Río Pánuco to Lake Chapala and the coast lay an area, stretching southward to beyond Guatemala, that had very early begun to forge ahead of the rest of North America. When the continuous archaeological record begins, perhaps some 2000 years ago, we find already established in this region peoples cultivating maize and beans, living in permanent villages and practising weaving and pottery. There were parts of Mexico, and of course of the rest of the Continent, that were never to attain this culture, which was however but an early stage in the history of the more advanced peoples. By 1519 we find several centres of civilization, each with traits of its own, but most of them possessing religious and social hierarchies, masonry temples and stepped pyramids, the art of metal-working, writing that showed signs of becoming phonetic, and an elaborate calendar.

The most powerful of these civilizations lay in the highlands—that is, in the *tierra fría* and the upper parts of the *tierra templada*—and in particular on the Mesa Central. This is the southern part of a great triangular plateau that gradually narrows, and at the same time rises in height, towards the south. All of it has permanent streams, coming down from mountains that rise as much as 10,000 feet above the plateau level of 6000 to 8000 feet, and in most places the rainfall is adequate for crops, though a wedge of steppe

1. The Spanish colonial scene (from the Uppsala map)



Phot. Bodleian Library

2. An Indian from the sixteenth century 'Codex Mendoza'

Phot. T. Ifor Rees

3. Otomi Indians today, carrying earthenware

climate (Köppen's *BS*) extends almost to Tenochtitlán. All told, the Mesa Central presents a highly favourable environment. Fertile, light and level alluvial soils are found in some of the intermontane basins such as the "valley" of Mexico (centre of the Aztec Empire) and in places, as around Lake Pátzcuaro, volcanic rocks have weathered into fertile soils. The rainfall and temperatures are usually not high enough to leach the soils and irrigation is practicable in places, but in the main not necessary. Though the Valley of Mexico suffers from occasional unseasonable frosts, the growing season is long. Moreover, the considerable altitudes of the Mesa Central temper the climate, so that food keeps longer and insects and microbes are less active than in the *tierra caliente*. At the same time, the proximity of the lowlands, and the considerable range of altitude within the Mesa Central itself, allow a diversity of products and encourage exchange. It is true that good agricultural land is limited and often sharply defined by the high and broken country surrounding the alluvial valleys or basins, but this itself encouraged intensive occupation.

The strongest polity on the Mesa Central, and indeed in the whole of Mexico, was the Aztec Empire, centred on the Valley of Mexico. The empire had been built up since 1429 by an alliance of three towns, the chief of which was Tenochtitlán, lying on an island in Lake Texcoco and connected to the mainland only by causeways. By 1519 the empire extended as far south as the isthmus of Tehuantepec and covered about one quarter of Mexico's present area. The conquered peoples were not incorporated into the Aztec kingdom and there were varying degrees of subjection. Usually tax-collectors or governors were placed in the defeated lands and were sometimes supported by garrisons. Sometimes an "alliance" was made, but the Aztecs always ensured their virtual dominance. From their empire they collected a variety of goods. The tribute roll of Montezuma lists several hundred towns; those of the *tierra caliente* sent such products as cacao, cotton, rubber and plumage, whilst the towns of the Mesa del Sur made a notable contribution of metals such as gold and copper, and of jade which was more valuable than either. Bulky items such as maize were not important, mainly because of transport difficulties. The Aztecs were also active traders and exported such typical plateau goods as obsidian spear-points, red ochre and rabbit-skin cloaks.

Whilst these conquests were going forward, society at the centre was becoming more complex. The primitive system of communally owned land in which separate families held only usufruct rights was giving way to a more stratified society. The ordinary Indian had to maintain a considerable number of priests, rulers and other privileged persons, some of whom had established hereditary rights, and there was a growing class of serfs. Aztec society was no doubt in transition and however free the typical Indian might still be in theory, he was in fact tied to the land since there was nowhere else he could go. "The Spaniards probably found more essential peons in Mexico than they made."[1]

The Aztec Empire never extended over the whole of the Mesa Central. The Tlaxcalans, for example, were a small but militarily strong people who

[1] A. L. Kroeber, "Native American population," *Am. Anthrop.* 36 (1934) 14.

successfully resisted all attacks. Over to the west lay the Tarascans, whose territory centred on Tzintzuntzan near Lake Pátzcuaro. Though in most ways less advanced than the Aztecs, they were a formidable military power with an effective expansionist strategy.[1] The Aztecs under Axayacatl (1469–81) had attempted to subjugate them but suffered so bloody a defeat that the attempt was not repeated.

The Mesa Central is limited on the south by a rugged escarpment leading down to the great trench of the Río Balsas, beyond which lies the Mesa del Sur. This enjoys some of the advantages of the Mesa Central but is far more dissected and has much less good agricultural land. Its western part in particular contained considerable enclaves of retarded culture about which little is known, but the Mesa del Sur also possessed two peoples of high civilization —the Tzapotecs, and the Mixtecs who were divided into three independent groups. In the arts of peace these two peoples were among the most advanced in Mexico, but by 1519 they had been made tributaries of the Aztec Empire.

The advanced cultures were however by no means confined to the highlands. Indeed, the highest achievements of the Maya were all in the *tierra caliente*. The first great Maya development (the so-called Old Empire) took place in the great area of rain forest that surrounds the Lake Petén savanas; but in 1519 the main centres were in the drier north and centre of the Yucatán peninsula. Cortés arrived at a period of political decline, when there were some eighteen groups of independent towns, but much of the culture and social stratification still remained.

The land occupied by the later Maya culture is a low limestone plain devoid of surface drainage or useful minerals. The vegetation is mainly scrub forest with some areas of savana (Plate 4). Although there was a considerable variety of wild fruits and animals to supplement agriculture and also an abundance of easily worked stone, the north of the Yucatán peninsula would hardly seem a likely hearth for so brilliant a civilization. It should also be noted that other advanced cultures occupied the *tierra caliente* as far as the Río Pánuco, that is the southern part of the Gulf coastal plain which contains considerable tracts of rain forest. Civilization there was at least as old as in the highlands or the Yucatán peninsula, probably older. Recent excavations at Tres Zapotes (in southern Vera Cruz) and elsewhere in the *tierra caliente* make it seem increasingly likely that Middle American civilization originated in the humid lowlands and spread later to the sub-humid lowlands and to the uplands. In any case, the high achievements in the *tierra caliente* suggest that the customary appraisal of humid tropical habitats needs reconsideration. It has indeed been suggested that the rainfall was less in the periods of high Maya achievement; but such changes remain hypothetical and cannot be correlated with historical events until a definite Maya chronology is established.

In the north of Mexico, beyond the Tarascans and the Aztec Empire, lay less advanced peoples. In the centre and east the boundary was sharply marked, but on the west there was a more gradual decline. In Jalisco, for example, there is no mention of the calendar, but many other characteristics of central Mexico were to be found. Beyond the Río Grande de Santiago

[1] D. Stanislawski, "Tarascan political geography," *Am. Anthrop.* 49 (1947) 46–55.

and up the narrow coastal lowland to a little beyond the Río Culiacán, lay a number of small independent groups cultivating flood-plains. In this area, which can conveniently be called Aztatlán,[1] population was dense along the rivers, metallurgy was practised and, in the south, even stone pyramids were found. Moreover, powerful *caciques* had imposed some degree of political organization and from many points of view we can link the "small states" of Aztatlán with the much more advanced peoples of the centre and south.

Between the rivers Culiacán and Sinaloa there was a sharp drop in cultural level, immediately apparent to the first Spanish observers, and influences from the Pueblo Indians to the north became more marked. Settled agriculturists were fewer and were intermixed with shifting cultivators; there was little storage of food, so that hunting and gathering had greater importance and there were some peoples (the Seri) who relied entirely on these. The Sierra Madre Occidental, too, was peopled by sparse and retarded tribes such as the Tarahumaras. These tribes extended right along the Sierra as far south as the Río Grande de Santiago, but their contacts with the more advanced peoples of Aztatlán and the south were both rare and hostile. Isolated, retarded and fragmented by the tremendous canyons and rugged slopes that characterize the Sierra Madre, they were entirely lacking in political organization and are therefore described by Mendizábal as "pre-political" in contrast to the more advanced societies, in which considerable and permanent authority was wielded by a minority.

Still more backward were the peoples of the Mesa del Norte, the northern part of the Mesa Central and the northern coastal plain of the Gulf. Most of them were savages (called Chichimecs by the Spaniards) living entirely by hunting and gathering, but there were a few enclaves of agriculturists, scattered along the rivers that flow from the moister uplands or in the scrub forest of the coastal plain. Much of the northern area is arid or semi-arid with internal drainage, and even on the plain the excessive evaporation and late arrival of the main rains may make irrigation necessary for cultivation. It is however certain that the savages occupied some tillable land. From ruins in Durango it is concluded that settlement had at some time (probably before the arrival of the Spaniards) extended over a wider area.[2] Certainly there were unused possibilities for irrigation and, especially in the south of the Mesa del Norte, there were well-watered regions still occupied by savages. The exact boundary between cultivators and savages would of course be decided not only by the potentialities of the land but also by force. In this conflict the Chichimecs had at least some of the advantages of the Old World nomads—few possessions, hardiness and high mobility. Several of their incursions are recorded; indeed the Aztecs themselves claimed to be the descendants of the savages who had partly destroyed and partly absorbed the Toltec culture. In the Old World such powerful states as Poland were built up at points of resistance to nomads and it is noteworthy that the two most powerful groups in Mexico, the Tarascans and the Aztecs, had a frontier with the Chichimecs.

[1] C. O. Sauer and D. Brand, "Aztatlán," *Ibero-Americana*, 1 (1932) 4–6.

[2] R. L. Beals, "Comparative ethnology of northern Mexico before 1750," *Ibero-Americana*, 2 (1932) 99–100, 152.

In Mexico there is plainly some relationship between aridity and retarded culture; in the Old World the main centres of early civilization were in arid lands traversed by "exotic" rivers, the Nile, Tigris, Euphrates and Indus. In Mexico crops were grown mainly on the *temporales*, land watered by rainfall, and although irrigation was practised there was no large group entirely dependent upon it. Even on the Pacific coast *temporal* cultivation was successful at least as far north as the Río Culiacán or the Sinaloa, and supplemented flood plain agriculture; there was some irrigation in the Mesa Central and lake water was used in the "floating" gardens. But all these were of local importance, the civilizations of Mexico were based on the *temporal*.[1]

A second characteristic of agriculture in Mexico was the use of wood ash to fertilize the ground. This *milpa* agriculture,[2] as it is usually called, was of course practised in the Old World, but no great civilization was there based upon it. The essential problem of *milpa* cultivation was that burned forest took time to re-establish itself, and the continuous cultivation of a piece of land was usually not possible. Soil exhaustion resulting from the growth of too dense a population may well explain the characteristic instability of the Middle American civilizations, their periods of brilliance followed by catastrophic decline and depopulation; and also of course the temporary or permanent abandonment of particular towns. In any case the large fallow area normally required in *milpa* cultivation would limit the growth of towns, which had to be fed from the surrounding countryside. The limit made itself more felt since there was no animal transport. Although some cities, such as Tenochtitlán, were fairly large, many were in fact ceremonial centres where lived the nobles, priests and merchants and were surrounded by a very extensive area in which houses were mingled with crop land.

The pattern of rural settlement was greatly changed by the Spaniards and it is difficult to form an impression of pre-Cortesian conditions. It seems likely that houses were often far apart. On the level plateau to-day, the houses of the Otomi are more than 150 feet apart, and there are documents to show that this was so in the sixteenth century.[3] The present-day Mijes also live dispersed and the basic pattern is probably pre-Cortesian. In 1921, for example, the municipality of Ayutla had 1400 inhabitants scattered over an area some 15 by 20 kilometres. The village itself consisted only of the school, church, municipality building and a few houses; it might indeed be described as a modern version of a small ceremonial centre.[4]

There were of course areas where population was more concentrated. This was the case where water supplies were few and distant, as in the mountainous part of the Otomi country where there are concentrated groups contrasting with the dispersion on the nearby plateau. Very limited tracts of

[1] Carl Sauer, "American agricultural origins" (in 'Essays in anthropology in honor of A. L. Kroeber,' Berkeley, 1936, pp. 279–97).

[2] O. F. Cook, "Milpa agriculture," *Smithsonian Inst. Ann. Rep.* (1919) 307–26. R. Linton, "Crops, soils, and culture in America" (in 'The Maya and their neighbors,' New York, 1940, pp. 32–40).

[3] J. Soustelle, "La famille Otomi-Pame du Mexique central," *Trav. et Mém. de l'Inst. d'Ethnol. de Paris*, 26 (1937) 57–9.

[4] O. Schmieder, "The settlements of the Tzapotec and Mije Indians," *Univ. Calif. Publ. Geogr.* 4 (1930) 70.

4. View from the Mayan temple "El Castillo," Chichén-Itzá

Photo. T. Ifor Rees

5. A Christian shrine surmounting a pagan pyramid

Phot. British Museum

6. Nuño de Guzmán in the Tarascan country (from the 'Lienzo de Tlaxcala')

Phot. American Mus. Nat. Hist.

7. Disease among the Indians (from the sixteenth century 'Codex Florentino')

cultivable land might equally force a certain agglomeration; in Aztatlán houses often formed a continuous line parallel to the rivers, the flood-plains of which were cultivated. The manner in which agricultural work was organized might also oblige people to live in fairly close juxtaposition; in the Tzapotec territory and in parts of the Mesa Central each person received a parcel in each newly cleared area so that his holdings were scattered rather as in the three-field village of the Old World. This dispersion of holdings led in the same way to the concentration of dwellings.[1] Among other forces making for agglomeration was the development of higher political organizations. Jilotepec, for example, lay on a level plateau in an area of typically scattered dwellings, but it was one of the political centres of the Otomi territory and the concentration of authority was matched by a concentration of population.

The distribution of population over Mexico as a whole showed a great contrast between the sparsely occupied north, and the centre and south which may have held over nine-tenths of the total population (and indeed about three-quarters of the total population of North America). Much of this was gathered on the Mesa Central, but parts at least of the *tierra caliente* probably supported dense populations also. In the past there had certainly been remarkably high densities in the lowlands, as when the Maya Old Empire was at its peak.

These contrasts, in the land itself, in the distribution of population, and in the attainments of the Indians, are striking; to assume a homogeneous Indian population is to miss an essential fact in Mexican history. The achievements of the advanced peoples were the more notable since their material equipment was in many respects stamped by a remarkable poverty as may be seen from the following table:

Found in Mexico and unknown in the Old World	*Introduced into Mexico by the Spaniards*
Maize, cacao, tobacco, *henequen* cochineal, agave (the source of *pulque*, an intoxicant).	Wheat, barley, sugar cane, banana, olive, vine, mulberry.
The turkey and a small hairless dog.	Horse, cattle, ass, mule, sheep, goat, mastiff, common fowl, silk-worm.
The use of rubber; the *coa* (a special type of digging-stick).	Iron; the wheel; the plough; wind and water power (mills and sails).

The Spanish innovations

Men first entered the Americas across Bering Strait, perhaps some ten or twenty thousand years ago. The early immigrants were hunters and gatherers and, although further immigrations followed and there were at least sporadic contacts with Oceania, there can be no doubt that American agriculture developed in effective isolation. A consequence, and also a proof, of this was that nearly all the domesticated plants and animals found in the Old World were unknown in the New, and *vice versa*. In the Old World, on the contrary, there was considerable contact between the various high cultures

[1] Schmieder, *op. cit.*, p. 15–16 and, for example, Pl. 30a and Map 5.

stretching from Britain to Japan, which had indeed common origins in the dry belt of Asia and Africa. Looked at in the broad view of universal history, the European discovery of the New World therefore represents the coming together of two main streams of human development. Never has there been such an exchange of plants, animals and techniques as that which followed the discovery of the New World.

Columbus had noted the absence of many plants and animals in the islands he visited and on his second voyage took over animals and seeds. By the time Cortés reached Mexico, cattle, asses, sugar and many other items had been introduced to the Isla Española and other islands; but Cortés was himself responsible for some transfers, such as that of the mulberry, direct from Spain to Mexico.

The innovations were not haphazard; [1] Cortés arranged for seeds and stock to be sent out in each ship leaving Spain; he complained of the attitude of Spaniards in the West Indies who were afraid of losing their monopoly in cattle; and himself undertook or sponsored experimental plantings of wheat and other crops. This constructive work was so actively pursued that by the end of the sixteenth century the Spaniards had introduced practically all the plants and animals with which they were familiar.

The introduction of new plants met with only partial success. In particular, many unsuccessful efforts were made to grow wheat before it was found to flourish in the valleys of Puebla and Mexico and in the Bajío. The Indians generally kept, and still keep, to maize as their staple crop. Their cultivation was by hand and often involved the clearing of bush or forest, and in places land was short; thus the yield was important and the yield of maize is much higher than that of wheat. It must also be remembered that wheat-eating would have involved a revolution in dietetic habits and attitudes.

The main new crops introduced into the *tierra templada* and the *tierra caliente* were rice, sugar, coffee and bananas. Some of these attained considerable importance; sugar was grown by Cortés himself at Cuernavaca. Plantations were also established along the coast and by the middle of the sixteenth century sugar was exported to Spain and Peru. The sugar cane was welcomed by the Indians and widely replaced the domesticated bee. Indian crops such as maize, cacao and cochineal proved of value to the Spaniards; cochineal in particular became a valuable export.[2]

Among the more specialized crops introduced by the Spaniards were the vine, olive and mulberry. The vine already grew wild in Mexico, but the cultivated variety was not very successful, the fruit being edible but the wine too sour; Acosta thought that the fruit did not ripen enough because of the July and August rains. It was later introduced by the missionaries into the region of Mediterranean-type climate in California. The olive also had only a moderate success in the sixteenth century when there was in fact no suitable climatic area for its cultivation. The mulberry and silk-worm had however a

[1] There is a useful summary in J. A. Robertson, "Some notes on the transfer by Spain of plants and animals to its colonies overseas," *The James Sprunt Historical Studies* (Univ. N. Carolina) 19, no. 2, 7–21.

[2] G. Gómez de Cervantes, 'La Vida Económica y Social de Nueva España al finalizar el Siglo XVI,' Mexico, 1944, esp. pp. 163–5.

brilliant though short career, especially in the Mixteca territory, but before the turn of the century the industry was greatly reduced. The rise of the Spanish silk trade with China was partly responsible, and the jealousy of Spanish interests also made itself felt.

While new crops had to compete with the Indian domestications, the Spanish horses, cattle, asses, sheep and goats had no Mexican rivals. Animals suitable for domestication were indeed unknown in North America and the domestic animals introduced by the Spaniards had therefore an even greater importance than their crops. In the Mesa Central and parts of the Mesa del Sur much of the land was already occupied, but cattle became important in the upland grasslands which had been of little use to the Indian. The Bajío, the intermontane basins through which the Río Lerma flows, was another lightly occupied area in which grazing soon became widespread, and the savanas of the Yucatán and the Gulf coastal plain were also utilized. By the middle of the century the Crown was issuing laws to protect the Indians' land from the encroachment of cattle-owners and the ravages of their animals, thus introducing into Mexico one of the enduring themes of Old World legislation. In the scrub and grasslands of the semi-arid north however such problems were of less importance, for there vast areas had been agriculturally useless before the Conquest and their utilization as grazing lands was one of the greatest revolutions in geographical values brought about by the Spaniards. In addition to the ranches which were established, wild herds of cattle and horses developed from stray animals. Coronado for example, who left Compostela in 1540 and penetrated as far north as Kansas, had to make a disastrous retreat and his horses, cattle, sheep and pigs were abandoned or hunted down by hostile Indians.

In the absence of suitable animals and of the wheel, human porterage was the main means of transport in pre-Cortesian Mexico (Plate 2), though boats were used on the navigable rivers and lakes. Gómara said that the Indians "blessed the beasts which relieved them from burden carrying," but Motilinía numbered porterage amongst his "ten plagues of New Spain." It is indeed likely that increased economic and military activity after 1521 led to a temporary increase in porterage, which would fall with particular severity in certain areas, as around Huejotzingo whence high passes lead to the capital, or near Acapulco where the land was too rugged even for mules.[1] By the end of the sixteenth century however the increased supply of animals and the building of bridges, as well as Crown restrictions on porterage and the establishment of customary practices, had reduced the worst abuses.[2] But porterage still continued, not only in the service of Europeans but as a feature of the whole country. Even to-day, animal power is incompletely used. One can well understand that the isolated Lacandon, living in dense rain forest, should still not use it—but what of the Huaxtecs, in whose market-places no carts are to be seen, everything being carried by men and women? Or the Otomi, still closer to European influence, who also rely mainly on their own

[1] H. H. Bancroft, 'History of Mexico,' San Francisco, 1883, vol. ii, pp. 332 *n.* 35 and 420.

[2] L. B. Simpson, "The repartimiento system of native labour in New Spain and Guatemala," *Ibero-Am.* 13 (1938) 70.

muscles, rarely possessing or using a donkey?[1] Or the man one notes tottering through the fashionable Paseo de la Reforma in Mexico City, the piano on his back held by a tump-line as in the Aztec codices?

It is remarkable that the wheel was so little used, even in hand carts. The Uppsala Map of the Valley of Mexico (Plate 1), which may be dated a generation after the Conquest, shows no wheeled vehicles and the Indian to-day often does not use them. The slowness of their spread was partly due to the almost complete lack of good roads in the sixteenth century; a modern parallel may be found in Tepoztlán, on the rugged southern escarpment, where in 1926–27 Redford noted the absence of wheeled vehicles. But this explanation does not meet all cases: the persistence of the tump-line can only be understood as part of a surviving cultural pattern, some elements of which have been held to unreasoningly. The idea of the wheel has not been welcomed by the Indians in either transport or pottery. In country where wheeled vehicles could not be used pack animals were increasingly employed by the Spaniards, but much less by the Indians.

The Indians were slow to acquire the larger animals and the warmest welcome was given to the humble hen, and to a lesser extent to the donkey. In the settled areas the Spaniards feared the military value of horses and prohibited Indians from riding or possessing them. Cattle were adopted only slowly and partially; their integration into Indian agriculture would not only have demanded a change in diet but would also have reduced the total yield of food. An acre under maize would support more people if its crop was eaten and not fed to cattle; and the hitherto unoccupied land that might have provided additional grazing was often seized by the Spaniards. Moreover maize, the core of the cultural pattern, was customarily cultivated with the digging-stick and not the plough, on land fertilized not by manure but by ash. Lastly, cattle are a kind of capital investment, as is clear in the Latin (*pecus*, *pecunia*), and the Indians' poverty and insecurity did not favour accumulation.

In much of Yucatán the plough cannot be used because the soil is only a few inches deep and limestone outcrops are frequent, whilst in all forested country ploughing would necessitate the uprooting of trees. Where the land is broken or rugged, the *coa* is superior to the plough and it is partly for this reason that in Western Guatemala "a plow is seldom seen."[2] But even amongst those Otomi who live on the level plateau the *coa* is used for maize though the plough is used for wheat. In Western Guatemala again, the plough is absent not only from the hilly areas but also from the level lands.

The introduction of the wheelless, usually iron-tipped, plough none the less initiated in places a great change in geographical values. With their stone, copper and bronze axes the Indians could clear forests and till the soil with digging-sticks, trees being killed by girdling and their roots left in the ground. Small shrubs and bushes actually presented greater difficulty since they usually had to be pulled up by the roots, and grass proved an almost invincible obstacle. Other advantages of forests were that they provided ash,

[1] J. Soustelle, *op. cit.*, pp. 71–3. W. Staub, "Le Nordest du Mexique et les Indiens de la Huaxtèque," *Journal Société Americanistes*, 18 (1926) 279–95.

[2] G. M. McBride, "Highland Guatemala and its Maya communities," *Geogr. Rev.* 32 (1942) 261.

and their soils are usually lighter and less compacted than grass sod. Pre-Cortesian agriculture was indeed virtually restricted to sandy and light loamy soils; the Tarascans were more or less confined to pine-covered volcanic slopes, which had light and friable soils, whilst the fertile but heavy and compacted soils of the valleys and of the Bajío to the north were very sparsely occupied.[1]

The iron axe and cutlass did not materially change the position, though they did enable a man to clear more bush or forest than before. For this reason, and also because iron made superior weapons, the Indians' demand for iron was as urgent as the Spaniards' demand for gold.[2] The plough however meant that grass could be ploughed under, and animal power and the iron tip could deal with heavier soils. The most important advance was on to the Bajío which became, and remains, one of the great cereal-growing regions in the country. The cultivated area was thus in places extended, though the occupation of heavier soils was of course far from complete; indeed, the advance continues to-day, aided by steel ploughs and heavier draught stock.

It will be seen that in agriculture and transport the Spanish innovations, though causing some important changes, attained only a partial and local success. It was in mining areas that new techniques and values came nearest to fulfilling their revolutionary potentialities. Mining became essentially Spanish in its capital and direction if not in its labour force. One of the main objects of the Conquest was to gain precious metals: as Cortés told an Indian chief, the Spaniards suffered from a disease of the heart for which the specific cure was gold. We may distinguish three stages of the cure.[3] In the earliest years the Indians' accumulations were looted and then for some decades the placer and residual deposits in the *tierra caliente* and elsewhere (some of which had been worked in pre-Cortesian times) were rapidly gutted. In 1546, with the discovery of the Zacatecas lodes, the final and revolutionary stage began. Gold and, more particularly, silver mines were established in the north both in the Sierra Madre Occidental and on the Mesa, sometimes in the very hunting grounds of the Chichimecs. This marked a new, and from many points of view the most important, phase in the occupation of the Mexican land. Mexico was established as a producer of raw, and especially precious, metals exported to distant markets, and so it remains to the present day. The change in the north itself was striking. The new mining towns were predominantly Spanish in culture, for the local population was usually sparse and the Indians brought from the settled areas had been torn from their old background. The influx of Spaniards was relatively greater than elsewhere and the *mestizo* (mixed-blood) became a typical figure in the north

[1] D. Stanislawski, "The political rivalry of Pátzcuaro and Morelia," *Annals Assoc. Am. Geogr.* 37 (1947) 135–44.

[2] For a vivid example of present-day "iron-hunger," see J. Soustelle, "La culture matérielle des Indiens Lacandons," *J.S.A.* 29 (1937) 20. In the first years of the Conquest, the Spaniards too were very short of iron. Thus, on the Pánuco expedition of 1523, nails and horseshoes cost their weight in gold (Bancroft, *op. cit.*, p. 101) and in Peru Hernando Pizarro and his troop made a memorable journey on silver-shod horses (W. H. Prescott, 'Conquest of Peru,' New York, 1847, Bk. III, ch. 6, *n.* 13).

[3] C. O. Sauer, "Personality of Mexico," *Geogr. Rev.* 31 (1941) 353–64.

far earlier than on the Mesa Central. The long distances and the transport of such bulky articles as foodstuffs, timber, mercury and silver made animal transport essential, whilst both climate and food-habits encouraged the cultivation of wheat under irrigation.

The development of mining in the north, together with its extension on old Indian sites such as Taxco, was but one consequence of the superior tools and methods of the Spaniards. In sixteenth-century Mexico man gained a new power over nature. Until 1519 the only known source of energy was human muscle: after 1519 running water drove mills; the wind drove windmills and propelled the ships that linked Mexico to the outside world; animals carried and pulled weights. Moreover, new devices meant that a given application of energy yielded more result—wheels reduced friction; iron edges cut deeper into rock or forest; gear, pulley and pump were at the engineer's service. At the same time the Spaniards were themselves acquiring and extending New World elements, such as maize, cochineal and agave, and were also introducing Indian plants, the potato for example, from other parts of the Americas. At the other end of the scale we find aboriginal groups that retained complete political independence and even had no contact at all with the Spaniards. Yet some of these groups received certain Spanish innovations, such as iron, the hen, the banana and the sugar cane, which spread rapidly from Indian to Indian. To add to the complexity, new inventions were being made: the Indians evolved a primitive sugar mill, and the Spaniards introduced from Europe such post-Conquest inventions as the mercury process in silver extraction.[1]

Even after the Spanish settlement the bulk of the population was formed by the subjugated Indians of the settled areas, especially the Mesa Central. The extent to which they took over Spanish innovations showed sharp local variations and Spanish elements were sometimes fitted into a pre-Cortesian pattern; the iron *coa* is an example. It may in general be said that the Indian was not Europeanized; rather he took over certain Old World techniques that allowed him to root himself more firmly in the soil. The essential fact and pattern of his life remained: the subsistence cultivation of maize.

Population and polity 1519–1600

In the decade following the fall of Tenochtitlán, the Spaniards rapidly occupied a vast area. By the early 1530's the northern limit of conquest ran from the mouth of the Río Pánuco, dipping south towards Mexico City and then running westwards towards the Río Santiago and up the north-west coastlands about as far as Culiacán. South of this line the only independent peoples were in the Yucatán peninsula, much of which was conquered by 1546, and in various smaller enclaves. It will be seen that the rapidly subdued area was in the main inhabited by Indians of advanced culture. Their life had, even before the Conquest, been cast in a definite mould. Some were accustomed to command and others to obey, and the Spaniards could replace

[1] E. Nordenskiöld, 'Modifications in Indian culture through inventions and loans,' *Comparative Ethnographical Studies*, 8, Göteborg, 1930; ch. 6 and p. 92. S. Linné, 'El valle y la ciudad de México en 1550,' Stockholm, 1948 (the Uppsala map and a valuable commentary).

the *caciques* or use them to subject the other Indians. Moreover, there were considerable population clusters, with recognized temples and markets, serving as centres for periodic ceremonies and exchanges. The Spaniards had only to pick up certain threads and a whole social network was in their grasp. Christian churches were often established on the sites of pagan temples (Plate 5); the dusky Virgin of Guadalupe appeared where once had dwelt Tonantzin, the Aztec goddess of motherhood and the Earth. The old sites were sometimes strategic; but what was more important, the Christian structures drew on a deep-rooted "goodwill" for the pagan element lingered on, turned to the Christians' ends.[1] It will be recalled that during the conversion of England a similar policy was recommended by Gregory the Great.[2]

North of the rapidly subdued area lay the *tierra de guerra*, the War Region. There the conquest was to be long, painful, piecemeal and harassed by raids. Vast areas of arid and broken land separated the widely dispersed Spanish settlements and proved apt refuges for hostile tribes. The sparse and scattered native population was less stable and disciplined than farther south and the Spaniards had themselves to weave a new social network. In spite of these difficulties ranching, and above all mining, made the subjugation of the north a worth while venture. In 1546 the silver lodes of Zacatecas were discovered and many other mining towns, such as San Luis Potosí and Guanajuato, soon began their astounding careers, linked to the south by escorted caravans moving along trails studded with forts. By the end of the century, the Spanish advance, backed by firearms and cavalry, had been carried about as far as the present international frontier, but the permanently pacified area was much more limited. Though the *tierra de guerra* was gradually shifted northwards, it remained a permanent feature of colonial Mexico.

The occupation of the north was but part of a wider movement. The arrival of the Spaniards introduced new elements into the appraisal of the Mexican land, and this occasioned new population groupings and the foundation of new towns (see Map). Changes in land use, routes, strategic needs, accessibility and social organization all made their influence felt. Ports such as Vera Cruz expressed the new connection with other lands; the occupation of the Bajío led to the rise of such towns as Valladolid (which was also a mining centre) and yet other towns, such as Puebla, were founded so that Spaniards should not settle in Indian centres. In some cases, notably that of Tenochtitlán, a city of high prestige which became the new capital, the Spaniards gave an increased importance to old sites, but more often the Indian centres declined. Such sites as Tzintzuntzan and Tlaxcala could not compete with rivals favoured by the government and often by a better adaptation to new conditions.

Concurrently with the founding of new towns the Spaniards undertook the *reducción*, the vast task of grouping the Indians into more compact and accessible settlements. In limited areas settlements were already compact

[1] M. O. de Mendizábal, 'La evolución del noroeste de México,' Mexico, 1930, 53–64, 79–89. R. Ricard, "La 'Conquête Spirituelle' du Mexique," *Trav. et Mém. de l'Inst. d'Eth. de Paris*, 20 (1933) esp. pp. 196–9. For Cholula, see *Geogr. J.* 48 (1916) 12 and the photograph facing page 16 in that paper.

[2] Bede, 'Hist. Eccles.,' I, xxx.

enough; elsewhere the *reducción* was a necessary condition for the conversion and exploitation of the Indian. At the end of the century the task was only beginning in the north (where the mission system had been evolved to meet the special conditions) and even in the settled areas the task was far from complete. The flight of Indians to isolated regions and the small grants of land (*ranchos*) made to poorer Spanish settlers were counter-currents making for dispersion of population, but the main trend is unmistakably towards the urban and compact village pattern that is so characteristic of present-day Mexico.[1]

The distribution of population was further changed by regional variations in birth and death rates. The latter in particular varied sharply at different times and in different places though, over the century as a whole, there was a marked decline in population. It is probable that the population was at least halved and the latest and most thorough consideration suggests that the reduction was even greater.[2] Many died in wars and revolts and some areas suffered particularly from the brutalities of the Spaniards and their allies (Plate 6). Aztatlán was overrun in 1530–31 "by about as hard a gang of killers as Spain let loose anywhere in the New World" [3] Many Indians were killed by over-work, especially in the *tierra caliente* where cacao cultivation was notoriously lethal. Humanitarians such as Las Casas naturally stressed the slaughter and the over-work, but more important was the spread of Old World diseases, such as small-pox and measles, to which the Indians had no immunity. It is probable that the pre-Cortesian Indians, with their few domesticated animals and relatively dispersed population, had been unusually free from devastating epidemics and that their "plagues" were largely the result of famines.[4] In the first century of the colony's history there were many minor and some major epidemics, killing hundreds of thousands and heralding famine (Plate 7).

The progress, or rather the decline, of the Indian population was anxiously watched by intelligent and responsible Spaniards. Plainly the Indian must work; the problem was to make him work without killing him under the burden. There was indeed a "warning from the West Indies," where the natives had in parts been wiped out within a generation [5] and both humanity and interest made it vital to avoid a repetition of this disaster. Underlying the varied and multifarious administrative measures of the Crown there was one constant aim; the establishment of a permanent and stable colonial society, with a pace of work that could last.

The attitude of the Crown, and of some Churchmen, was undoubtedly paternal; a small but vivid illustration of this will be found on Plate 1, which includes the distribution of food at the convent of Santa Fé. But it was

[1] G. Kubler, "Mexican urbanism in the sixteenth century," *Art Bulletin* (*College Art Association of America*), 24 (1942) 160–71.

[2] S. F. Cook and L. B. Simpson, "The population of Central Mexico in the sixteenth century," *Ibero-Am.* 31 (1948). See also G. Kubler, "Population movements in Mexico, 1520–1600," *Hisp. Am. Hist. Rev.* 22 (1942) 606–43.

[3] C. Sauer and D. Brand, *loc. cit.*, p. 41.

[4] S. F. Cook, "The incidence and significance of disease amongst the Aztecs and related tribes," *Hisp. Am. Hist. Rev.* 26 (1946) 320–35.

[5] Hernando Cortés, 'Five letters, 1519–26,' trans. J. B. Morris, London, 1928, p. 285.

also necessary to be repressive, for even at the end of the century the fifteen thousand Spaniards in the colony were vastly outnumbered. The caciques were therefore usually confirmed in their privileges and even granted new ones in return for dragooning the rest of the Indian population. The Indian was left with little defence against exploitation. Working hard, too hard, for his new masters and reeling under the terrible impact of war and disease, he lacked the capital to buy ploughs or cattle or to risk the cultivation of new crops. Even some of the measures designed to protect him, such as the prohibition on Spanish residence in Indian towns, tended to perpetuate his ignorance. Most important in this connection was the *repartimiento* system by which Indians were obliged to present themselves for hire to neighbouring Spaniards. The Crown, anxious to avoid both slavery and feudalism, attempted to preserve the Indians' land and water rights, and the *repartimiento* was necessary to force the self-subsistent cultivator into economic activity; the Indian was hired out for only so many days each year and was free to cultivate his own land as he wished. And so, his ignorance unenlightened and his conservatism unchallenged, toiling for harsher masters and a more exacting God, the Indian coasted the margin of life and death and could count it a success if he kept alive. There was little room for innovation.

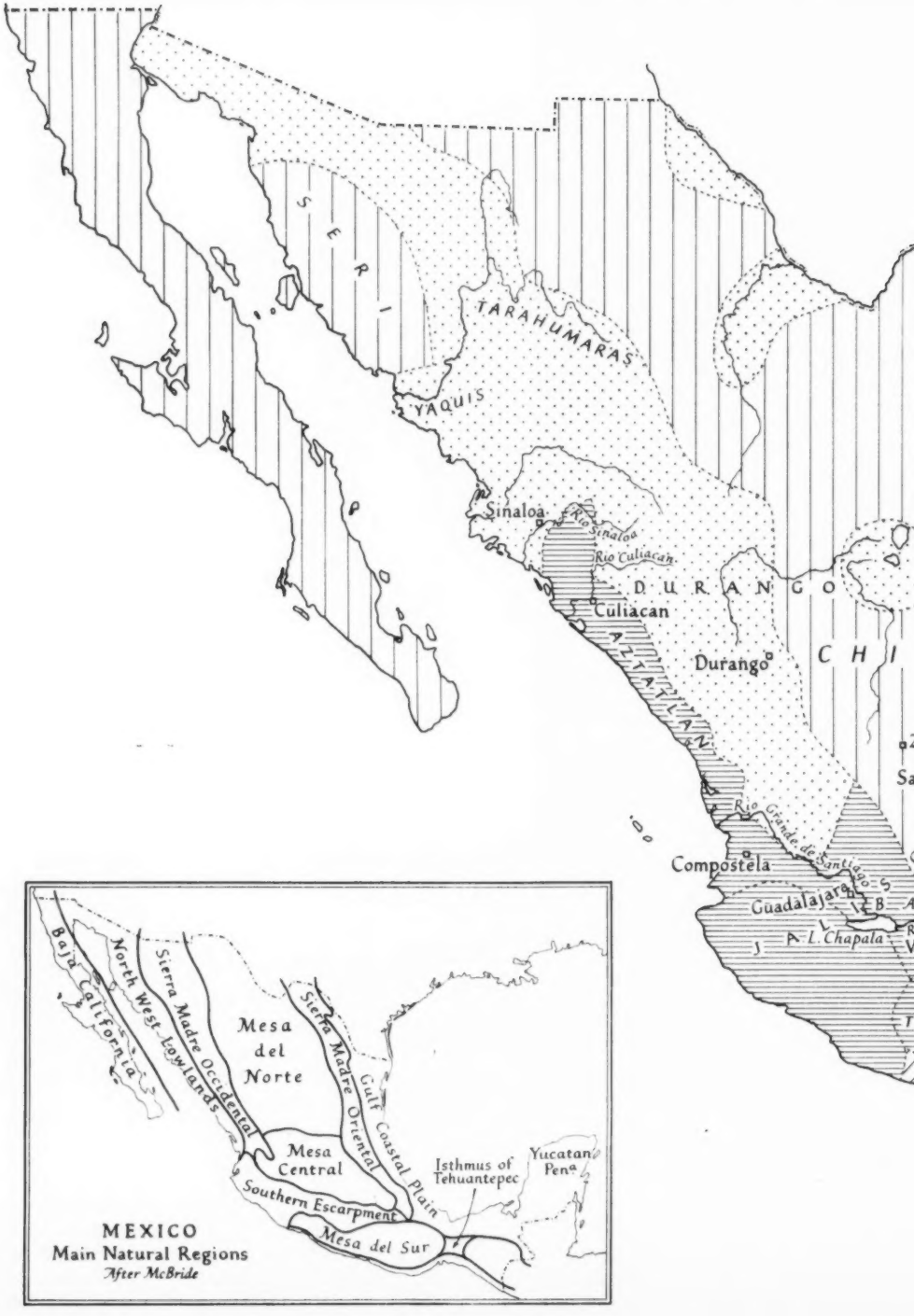
But if the Spaniard was shackling the Indian he was also in a sense shackling himself. The Anglo-Saxons to the north were to brush aside the native and come to grips with the land, but the main work of the Spaniard was to define the tutelage of the Indian. The great estates built up by individuals, and above all by the Church, were essentially concerned with controlling labour and showed no great urge towards technical innovation. The full utilization of Old World equipment was further checked by the increasing tendency of the Crown to discourage industry and the cultivation of crops that might compete with production in Spain. Lastly, the connection with Spain was already tenuous enough because of the difficult sea-passage and the mounting threat of piracy, and restrictions were placed on the arrival of goods, ideas and persons from foreign lands. "Mexico," observes Parkes, "lived in a seclusion almost as great as before the voyage of Columbus." [1]

The New Pattern

The Conquest brought about many striking geographical changes. Old World crops, animals and tools drew a new tribute from the land, and improved communications and extended markets permitted great developments in mining and cochineal cultivation. The distribution of population was changed by the founding of new settlements and the decline of old, by regional variations in the death-rate and by the *reducción*. The contrast between pre-Cortesian and colonial Mexico was however less complete than might be expected; in spite of important changes in their distribution, the concentration of Indians on the Mesa Central endured into the colonial period and for many reasons they adopted only parts of the Old World equipment.

The Spaniards found the freest scope for innovation in areas that had been but lightly occupied by the Indians, but in general the new society they

[1] H. B. Parkes, 'A history of Mexico,' London, 1939, p. 133.


SERI
TARAHUMARAS
YAQUIS
Sinaloa
Rio Sinaloa
Rio Culiacan
DURANGO
Culiacan
Durango
CHI
Rio Grande de Santiago
Compostela
Guadalajara
L. Chapala
Baja California
North West Lowlands
Sierra Madre Occidental
Mesa del Norte
Sierra Madre Oriental
Gulf Coastal Plain
Mesa Central
Isthmus of Tehuantepec
Yucatan Pena
Southern Escarpment
Mesa del Sur
MEXICO
Main Natural Regions
After McBride

SIXTEENTH CENTURY MEXICO

showing the status of Indian Societies in 1519
and selected towns founded by the Spaniards

After Mendizabal and others

forged was restrictive and mercantilist and in some ways discouraged innovation. In sixteenth-century Mexico the equipment, practices and settlements of the Old and New Worlds were found in every kind of combination and opposition; and both conquest and innovation made unequal progress in different parts of the country. Wheat, for example, could be grown only in limited areas and the plough could not be used in Yucatán. Again, at the end of the century there were independent tribes in the depths of the Sierra Madre Occidental that were still in the stone age, whilst Tenochtitlán, rebuilt and renamed Mexico City, boasted a University. The conquest, it is true, destroyed the higher manifestations of the diverse Indian civilizations but it created many new and sharp contrasts, some of which have been described.

Even where the break with the past was greatest, old physical contrasts found expression in new human terms. The north, for example, came to be characterized by mining and ranching, by irrigation, by guerrilla warfare and by a population showing strong Spanish influences; but still contrasted with the centre and south with their subjugated and predominantly agricultural Indian population. A richer material equipment thus underlined natural differences; it allowed man to make, as it were, a finer commentary on nature.

Diversity of land, diversity of life. These were emphasized by the conquest but existed at the very beginning of the continuous archaeological record and remain essential features of the country to-day.

Acknowledgement

I wish to offer my sincere thanks to those who have helped me. Mr. A. F. Martin and Dr. Jacques Soustelle kindly read the manuscript and made valuable suggestions; Mr. T. Ifor Rees, C.M.G., generously provided a selection of his own photographs; Mrs. Edna Barron and my brother, Mr. Bernard Poole, helped in many ways.

THE RANGE OF VARIATION OF THE BRITISH CLIMATE

GORDON MANLEY

PART I. CLIMATIC FLUCTUATIONS IN MODERN TIMES

TO MANY of us the virtues of our day-to-day changeable weather are manifest. Seventy years of standardized meteorological records give us a good idea of the limits within which any day's events are likely to fall. In the southern English lowlands a fall of two feet of snow, a shade temperature of 97°, or a month with 70 per cent. of the possible sunshine, represent extremes unlikely to be surpassed. Superimposed upon our day-to-day weather however we now recognize that small but definite fluctuations of climate exist and that since about 1925 an appreciable amelioration has set in round the North Atlantic. Professor Ahlmann has recently reviewed the many associated events.[1] It remains for us to consider the possible amplitude of the variation of our climate in Britain, as distinct from the weather.

I shall first comment on the magnitude of the present fluctuation in Britain, in terms of overall mean temperature. I shall follow with some evidence for past fluctuations provided by the instrumental records since 1700, relating them to the earlier climatic recessions demanded by the pollen-analysts in historic and prehistoric time. In the second part of the paper I shall address myself more to those technical experts who are acquainted with the geological and botanical background, and I shall give estimates for the temperature of the various phases since the last Glacial maximum in order to compare the range of variation over which our climate appears at intervals to have changed. In my view it is high time such estimates of the mean temperature of summer and winter were made, and an opportunity of doing this for Late Glacial times is now provided by using Professor Ahlmann's relationships between the height of the snow-line, the amount of accumulated precipitation and the mean temperature of the ablation season.

Comparisons between present-day fluctuations and past changes may throw light on the possible causes of climatic variation; some will be led to consider whether the present amelioration in north-west Europe will continue, and for how long. Throughout this paper I shall largely confine attention to the mean temperature of January and July as a sufficient initial indication of winter and summer characteristics. Periods of disturbed weather when the oceanic influence is greater are characterized by a diminished January–July range; in quieter and more "continental" phases the range increases. Meteorological aspects of this "varying vigour of the atmospheric circulation" are discussed by Ångstrom [2] and Willett.[3]

[1] H. W:son Ahlmann, "The present climatic fluctuation," *Geogr. J.* 112 (1948) 165–95.

[2] A. Ångstrom, "The change in the temperature climate in present time," *Geogr. Ann.* 21 (1939) 119.

[3] H. C. Willett, "Long-period fluctuations of the general circulation of the atmosphere," *Journ. Met.*, 6, 1949, pp. 34–50; "Solar-variability as a factor in the fluctuations of climate," *Geogr. Ann.* 31 (1949) 295. See also *Q. J. R. Met. S., Centenary Proceedings*, 1950.

Fluctuations of the mean temperature of the growing season, roughly March to November in southern England, are likely to be of major importance to our welfare. Our annual evaporation-loss varies about four inches on either side of sixteen, and seven-eighths of it takes place during April to October; in most years it considerably exceeds the lowland rainfall for those months. With a small rise in temperature evaporation increases and hence the available moisture for plant growth, the run-off and the percolation will be affected; moreover in many summers such a rise of temperature accompanies a greater predominance of anticyclonic weather and a further decrease in rainfall. Fluctuations in the mean temperature of the growing season are also likely to run broadly parallel to variations in the height of the snow-line and of the mountain glaciers, whose behaviour depends so largely on the length as well as the warmth of the ablation season. In north-west Europe the height of other lines, such as that at which permanent snowbeds are found, the altitudinal limit for trees, and that at which grass will grow from early May to early October, should also vary in the same general sense. In Britain this last line gives a useful definition of the potential limit for upland enclosed and improved pastures; it lies at about 1800–2000 feet in the northern Pennines.

The recent amelioration in Britain

The initial stages in the present improvement appear to have set in about 1925–30, for example in Iceland.[1] It is convenient to use my "Lancashire" table [2] to illustrate the overall effects on temperature in Britain, referring as it does to an area centrally situated; and to compare the means for the period 1931–50 with those for 1901–30 which is widely used as a standard in Europe. As the figures show, every month from March to December shows a rise.

Taken over twenty years such figures, in conjunction with the other phenomena described by Ahlmann, are significant. Spring, summer and autumn are all about a degree warmer. Winter averages have fallen a little, thanks to the occurrence of five quite severe seasons since 1939; but it will be observed that we have had little protracted cold in spring and that Aprils in particular have become warmer. Some authorities regard this sequence of events, culminating in an increased January–July range, as indicative of "weaker atmospheric circulation" or "increased continentality," following the prevalent "maritime" spell in the 1920's. On similar grounds the late eighteenth-century climate was as a whole more "continental."[3, 4] It is also to be noted that the 1940's taken overall were one of the most favourable periods in this respect since the outstanding series of favourable warm summers about 1772–1783 which stand out in the Stockholm and Utrecht records as well as our own.

The effect with regard to the growing season is also noteworthy. To show the vicissitudes since 1750 I have used the "accumulated temperature" above 42° in "month-degrees" for each year (Fig. 1), interpolating from the monthly

[1] J. Eythórsson, "Temperature variations in Iceland," *Geogr. Ann.* 31, 1949, 36.

[2] G. Manley, "Temperature trend in Lancashire," *Q. J. R. Met. S.* 72 (1946) 1–31.

[3] A. Labrijn, "The climate of the Netherlands over the past 2½ centuries," *Med. en. Verh. Kon. Ned. Met. Inst.* 49 (No. 102) 1945.

[4] D. J. Schove, Contribution to discussion on post-glacial climatic change, *Q. J. R. Met. S.* 75 (1949) 175–178.

Table 1

Monthly mean temperatures for the "Lancashire Plain" (Fahrenheit)

	J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Year*
1901–1930	39·5	39·6	41·8	45·5	51·6	56·0	59·4	58·6	55·1	49·3	42·3	39·8	48·2
1931–1950	38·2	39·5	42·5	47·0	52·0	57·5	60·4	60·2	56·3	49·9	44·1	39·9	48·9
Departures from 1901–30	− 1·3	− 0·1	+ 0·7	+ 1·5	+ 0·4	+ 1·5	+ 1·0	+ 1·6	+ 1·2	+ 0·6	+ 1·8	+ 0·1	+ 0·7

	Winter	*Spring*	*Summer*	*Autumn*
Departures for the **seasons**	− 0·4	+ 0·9	+ 1·4	+ 1·2

Highest and lowest decadal means of temperature for summer (June–August)

Lancashire	Normal 1901–30	58·0			
	Warm Decade 1772–81	60·5	Relatively Warm Decade 1940–49	59·3	
	Cool Decade 1809–18	57·3	Relatively Cool Decade 1881–90	57·7	
	CLIMATIC OPTIMUM (approx.)	61·5			
Holland (Utrecht) ..	Normal 1901–30	60·4			
	Warm Decade 1772–81	62·7	Relatively Warm Decade 1940–49	61·8	
	Cool Decade 1809–18	60·1	Relatively Cool Decade 1881–90	60·4	
	CLIMATIC OPTIMUM (approx.)	64·0			

(Holland, warmest decade 1774–83. Stockholm, warmest decade 1775–84)

Highest and lowest monthly means on record: Lancashire

J	*F*	*M*	*A*	*M*	*J*	*J*	*A*	*S*	*O*	*N*	*D*	*Year*
45·3	46·5	47·5	50·5	58·5	64·0	64·8	64·8	61·0	55·3	48·5	46·4	50·6
(1916)	(1779)	(1938)	(several)	(1833)	(1846)	(1808) (1852)	(1947)	(1865)	(1921)	(1818) (1938)	(1934)	(1949)
25·6	28·9	33·5	39·9	46·5	52·9	55·3	54·5	48·7	42·6	35·0	30·0	44·5 (approx.)
(1814)	(1855)	(1785)	(1837)	(1782)	(1823)	(1816)	(1912)	(1807)	(1817)	(1782)	(1878)	(1740)

means. For convenience as well as interest I took out the approximate values applicable to places at a height of 600 feet in the Pennines, an area marginal as regards cultivation. It will also be noted that the length of the growing season has not varied so widely as its intensity.

Several minor fluctuations can be recognized since 1750; but it is evident that any slight tendency in one direction or another rarely prevails for more than nine consecutive occasions out of ten, whether we consider single months, seasons, or whole years. For example we find the warm summer of 1884 and the warm winter of 1775 within decades characterized by coolness

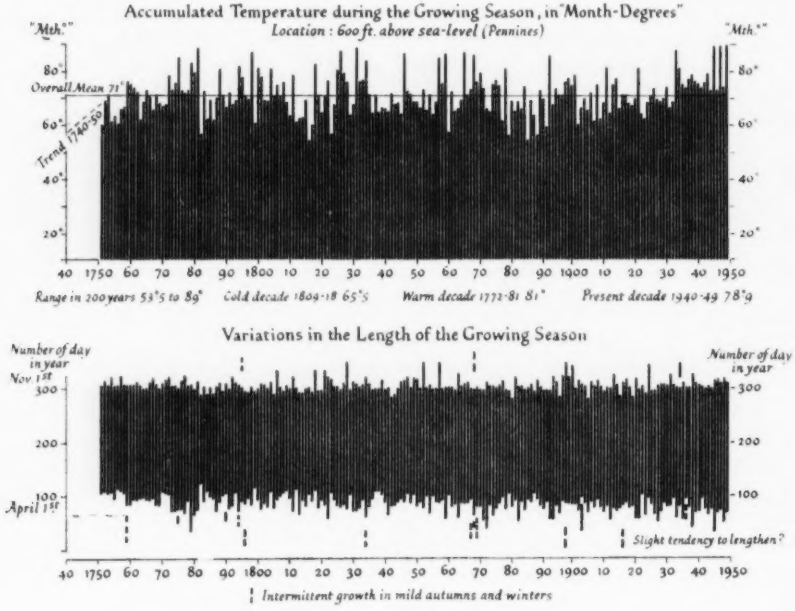

Accumulated Temperature during the Growing Season, in "Month-Degrees"
Location: 600 ft. above sea-level (Pennines)
"Mth."
80°
Overall Mean 71°
60°
Trend 1740-50
40°
20°
40 1750 60 70 80 90 1800 10 20 30 40 50 60 70 80 90 1900 10 20 30 40 1950
Range in 200 years 53°5 to 89°
Cold decade 1809-18 65°5
Warm decade 1772-81 81°
Present decade 1940-49 78°9
Variations in the Length of the Growing Season
Number of day in year
Nov. 1st
300
200
100
April 1st
Slight tendency to lengthen?
Intermittent growth in mild autumns and winters

Fig. 1. Temperature fluctuations, 1751–1949

at those seasons. In any longer temperature record it is similarly rather hard to find a succession of twelve months above or below the average. Stability, or even persistence, over long periods is therefore not easy to explain; moreover *varves* and tree-rings show similar minor groups of years and of course these have led to much work on sunspot correlations and teleconnexions, with disputable results.

We may also note that the evidence points to an appreciable contemporary rise in temperature of the surface waters of the north-eastern Atlantic.[1, 2] In

[1] J. Smed, "The increase in the sea temperature in northern waters during recent years," *Rapports et Procés-Verbaux, Conseil Permanent International pour l'exploration de la mer*, 35 (1948).

[2] J. Eythórsson, *op. cit.*

the fact that, taken over twenty years, our summer means of air temperature have risen more than those of winter have fallen and in the mildness of autumn accompanying the rise in spring, it is tempting to recognize the superimposition of a slightly increased annual range (due to weaker atmospheric circulation) upon the effects of a rise in temperature of the surrounding ocean waters which has affected our principal air-mass, the "maritime-polar." In turn, maritime-polar air tends to reach us with a longer sea-travel, due to the westward displacement of the Icelandic Low. I offer the interpretation that the longer-term determinant of the pitch about which our climatic tune oscillates is set by the ocean temperature and that owing to the effects of the Arctic ice this may in some measure be independent of that of the overlying air. I shall later try to show that this was operative in the Late Glacial period.

Some minor geographical effects of these small fluctuations may be touched on. In northern England the length of the growing season decreases by about ten days for each 260 feet of altitude [1] and, other things being equal, our planners should be able to estimate the increased area open to cultivation; but this is not so easy, because spring temperatures decrease with height more rapidly than those of autumn. The variability of the "accumulated warmth" also increases with height and is calculable. At 600 feet it lies, as is shown in Fig. 1, between 75 and 125 per cent. of the mean; but at 2000 feet the variation is from under 50 per cent. to over 150 per cent. That is, the ratio between the "growing capacity" of the best and worst years based on air temperatures, is twice as great at 2000 feet as at 600 feet.

Should the recent amelioration continue, the promise of return from our uplands is evidently considerable. But while its magnitude may now be appreciable and altitudinal limits for cultivation should have risen by about 250 feet, the decadal warmth of the growing season has by no means attained that of the 1770's. Nor can we afford to overlook the suddenness of the interruptions to which these slight trends appear to be liable (*cf.* 1740, 1784, 1837). Further, so far as the experience of the last 250 years is valid, it does not look as if we should expect any similar tendency to prevail throughout a further decade, whatever may occur in individual years.[2]

It must also be stressed that any slight rise in the overall averages we are experiencing has not greatly diminished the chances of frost. In springtime at least, cultivators of exotics will demonstrably gain far more by careful choice of site than from any climatic trend so far recognizable. I make this assertion because I took out the approximate number of mornings with a minimum air temperature 32° or below from Jonathan Dalton's early morning observations at Kendal, 1793–1809, when the winter months were colder than now. Table 2 shows that, given the same type of location, the annual average frequency has not greatly changed. In spite of several sharp winters however it is interesting to note that the average for 1931–49 is slightly below that of 1914–30. Among other minor effects, we may recall the disappearance on more than one occasion since 1933 of the reputedly "permanent" Scottish

[1] G. Manley, "The effective rate of altitudinal change in temperate Atlantic climates," *Geogr. Rev.* 35 (1945) 408–417.

[2] Compare here G. Liljequist, "On fluctuations of the summer mean temperature in Sweden," *Geogr. Ann.* 31 (1949) 159.

snowbeds.[1] On Ben Nevis the theoretical snow-line has risen by about 300 feet since the beginning of the century.

Table 2—Average annual number of mornings with minimum (air) 32° or below

Present:		
Cockle Park 325 feet (open pasture, Northumberland)	1914–47	70
	(1931–49	60)
Mayfield 374 feet (valley-floor by Ashbourne, Derby)	1921–40	83
Renfrew 19 feet (valley-floor airfield, Glasgow) ..	1921–40	64
	(1931–49	54)
Stonyhurst 377 feet (favourable slope, Ribble valley)	1915–40	57
	(1931–49	47)
Past:		
Kendal 145 feet (valley-floor, Westmorland)	1793–1809	72

(Approximation for 1793–1809 based on 6^h and 8^h daily readings by Jonathan Dalton)

The amplitude of earlier fluctuations since the "Climatic Optimum"

Pollen analysis shows that our post-glacial "Climatic Optimum" was reached between five and six thousand years ago, since when several recessions have occurred. These results have been recently summarized by von Post [2] and in each case the pollen diagrams indicate that the north-west European climate crossed a threshold, indicative of a change in the character of the summers in the direction of greater coolness and dampness than at an earlier stage. Subsequent climatic recoveries have taken place but have never been sufficiently protracted to reproduce the conditions of the optimum; in other words we may have already passed the peak of an "inter-glacial." Dr. Verona Conway [3] has recently shown that the recessions appear to be roughly 900 years apart. That marking the onset of the Sub-Atlantic, about 500 B.C., has long been recognized, but in Scandinavia a minor recession is now placed about A.D. 1300.

Dr. C. E. P. Brooks thinks that in the Climatic Optimum the Arctic may have been almost clear of sea-ice, and the mean annual temperature at Spitsbergen certainly rose above the freezing point. The seas round Britain were a little warmer than now (of the order of 3° F. compared with 1901–1930). But there was still a Greenland ice-cap and no doubt a strong winter High over Siberia, offsetting in some measure the effects of a warmer North Atlantic. Iversen has given averages for Denmark for that period (for January 0·5° C. above present and for July 2° C. above).[4] I think these can be taken to show that, during the Optimum, the average July temperature in the Thames valley attained 66°–67° F. and in Lancashire 63°; about 3° above the present values. With persistent summer means of that order the

[1] G. Manley, "The snowline in Britain," *Geogr. Ann.* 31 (1949) 179.

[2] L. von Post, "The prospect for pollen-analysis in the study of the earth's climatic history," *New Phytologist*, 45 (1946) 193.

[3] V. Conway, "Von Post's work on climatic rhythms," *New Phytologist*, 47 (1948) 220.

[4] J. Iversen, "*Viscum*, *Hedera* and *Ilex* as climatic indicators," *Geol. Foren. Stockholms Forh.* 66 (1944).

tree-line would gradually rise to about 900 feet above its present level; that is it would approximate to 3000 feet in Central Scotland. Other evidence confirms this, and von Post gives a round figure of 1000 feet for the rise in Scandinavia.

During the Climatic Optimum the south to north temperature gradient in early spring would probably be less marked than now. In this respect the present offers a key to the past; compare the data for the recent warm Marches of 1938 and 1949, in each of which the excess above normal was two degrees greater in eastern Scotland than in south-east England. The above values for July in England are no higher than those which prevail at the present day in warm anticyclonic summers; this is illustrated in Table 3. Moreover, a decade with nine warm summers occurred in 1772–81, giving for that season a mean temperature 2° or more above that of 1901–30. Single summer months have attained 6° to 7° above the same "normal."

Table 3—Departures (from the normal characteristics for 1901–30) of exceptional warm and prolonged anticyclonic summers

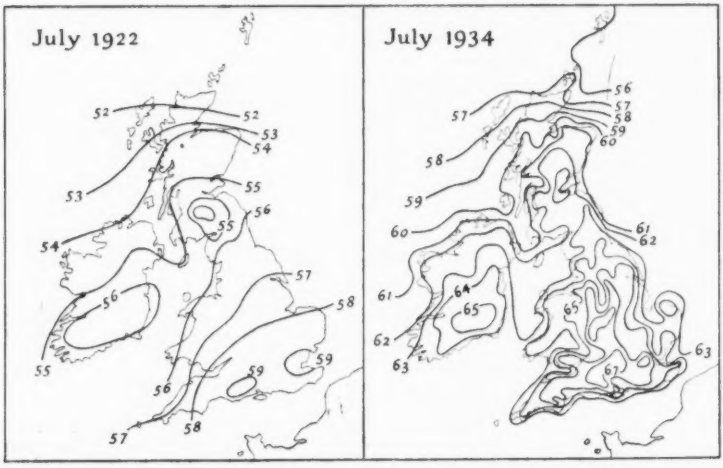
		June	*July*	*Aug.*	*Sept.*	*Mean Excess*
London (Kew)	1949	+3·3	+3·9	+3·9	+7·5	+4·7
	1947	+3·1	+2·8	+6·4	+3·4	+3·9
	1933	+2·6	+5·3	+4·6	+4·2	+4·2
"Lancashire"	1949	+2·7	+2·3	+2·7	+5·2	+3·2
	1947	+2·5	+1·7	+6·2	+2·8	+3·3
	1933	+3·6	+3·5	+4·0	+3·4	+3·6
	1911	+1·1	+3·0	+4·9	+0·5	+2·4
	1868	+2·1	+4·6	+3·4	+2·7	+3·2
	1857	+4·0	+0·8	+4·2	+2·6	+2·9
	1846	+8·0	+1·4	+3·7	+3·2	+4·1
	1826	+6·9	+3·7	+3·5	+0·9	+3·7

We may effectively contrast the isotherm pattern arising from a fine warm summer month (July 1934) with that characteristic of a cloudy, cool and unsettled summer month (July 1922); note how in Figure 2 the 59° isotherm moves from southern England to north Scotland.

From this it is evident that if a spell of "weaker atmospheric circulation" becomes dominant through a group of summers, the mean temperature at comparable distances inland in Britain is of the order of 3° above the average which is likely to prevail under conditions of "more vigorous circulation." Between exceptional summers the difference may attain 6° (1868 and 1879 for example).

We may now note that Iversen's estimates for the Sub-Atlantic in Denmark indicate a fall in the July mean of about 3° F. from that of the preceding Sub-Boreal. The vegetation changes accord with the increased cloudiness and decreased evaporation accompanying this fall of temperature. This all points to the explanation of the recession as due to increased vigour of movement of the Atlantic air, which is supported by the fact that the winter temperatures remained relatively mild. But although the results were longer-lasting, the dimensions of the climatic change were not greater than those which we may observe by comparing groups of years within our own experience.

Dr. Brooks has given evidence for subsequent minor recessions and improvements, for example the amelioration of Anglo-Saxon times and the deterioration about A.D. 1300 which was decidedly effective in Norway. We may attribute these in similar fashion to varying vigour of the circulation. From the fact that we have no very convincing record of the extensive cultivation of vines in England in medieval times it appears to me that even in favourable groups of years the mean temperature of July is unlikely to have swung more than 3° above its present value. For if a long series of quiet fine summers gave a July mean in the Thames valley above 66°, the climate would be marginal for wine-making. Such a spell may have occurred in the late thirteenth century, but was not lasting.



Cool, cloudy, unsettled, westerly *Warm, often anticyclonic*

Fig. 2. Typical isotherms for cool and warm summers

With regard to winter cold; since the climatic optimum our seas must always have remained ice-free, and this appears to set a lower limit below which the mean temperature of a winter month cannot go. From Dr. Brooks' early papers on continentality and climate, and the example of places such as Hangö in Finland, even with a complete snow-cover we should not get a coastal monthly mean below about 27° and an inland mean, in an island of this size at sea-level, below about 23° or 24° unless the North Sea were to freeze over.

Within the last 200 years these extreme values of mean monthly temperature, say, 70° and 23°, have been nearly attained. Disregarding exceptional urban stations such as those in London, we may quote 68° at Reading in July 1921 and 24·5° to 25° by reasonably well-exposed instruments at Perth and Carlisle in January 1814. We appear to have acquired instrumental knowledge of practically the whole gamut of possibilities that our climate may

offer us during a life-time, unless the sea surface changes markedly in temperature over a prolonged period.

In conclusion, the changes since the Climatic Optimum are attributable to the predominance, over shorter or longer periods, of patterns of the atmospheric circulation which can be described as more or less vigorous [1]; "maritime" or "continental"; or, using Willett's terminology, of "high and low zonal index." [2] These effects may be associated with or partly imposed upon the results of small changes in the ocean surface temperature of the North Atlantic arising from variations in the extent of the Arctic ice. Minor fluctuations can be recognized within the last two centuries which may not have been so persistent, but have approached in magnitude the variations for which there is botanical evidence in the past 5000 years. Experience of the past 200 years indicates that the present tendency for warmer summers might go a little farther, but inasmuch as it has already persisted over two decades past experience does not justify the expectation that it will. If it does, short but cold winters will still at intervals occur, in accordance with a "continental phase"; and the accumulated warmth of the growing season together with the evaporation will also increase. If so, while agricultural yields may improve, further precautions with regard to water supply in the south-east will be necessary. There is however no reason yet to assume that we shall not undergo another minor recession, characterized by a renewed advance of the European glaciers and by one or more cold springs and cool dull summers within the next few years. From the events of the next two or three decades we may expect abundant clarification of this problem of explaining the minor and major changes which our climate has undergone.

PART II. THE DIMENSIONS OF THE CHANGES IN THE BRITISH CLIMATE BEFORE THE "CLIMATIC OPTIMUM"

"It might not require so violent a depression of temperature as we might at first suppose, to account for any extension of the glaciers which the facts may require us to admit." So wrote J. D. Forbes with his usual brilliance of perception, a century ago.[3] With that in view, and in an endeavour to provide estimates for the much more controversial and remote period before the Climatic Optimum, I shall take leave to summarize much of the technical evidence; references are given which can be followed up by those interested.

So far we have largely discussed the instrumental record and we have referred to Willett's view with regard to the possible causes and dimensions of changes. He suggests that the dimensions of the minor secular fluctuations of which we have knowledge appear to be about half the order of magnitude of those comprised in the post-Glacial and historic period since the Climatic Optimum.[4] The question that remains is why the high- and low-index patterns of the circulation that he demands should sometimes appear to

[1] Ångstrom, *op. cit.* [2] Willett, *op. cit.*

[3] 'Travels in the Alps' (1845 edition), pp. 44–45.

[4] H. C. Willett, "Solar variability as a factor in the fluctuations of climate," *Geogr. Ann.* 31 (1949) 299.

prevail for long periods, whereas within the instrumental record they have not done so for more than a few years. It is possible that they bring about changes in the sea-surface temperature which, once established, last for a considerable time. It is possible that a pattern which involves much meridional transport of air and storminess in high latitudes is associated with a widespread break-up of the margins of the Arctic ice. Dr. Brooks suggested many years ago that a rapid growth in the area of the Arctic Ice might explain such climatic deteriorations as that which initiated the "Sub-Atlantic" recession.

We must also bear in mind the possibility that the sea surface temperature over wide areas of the north Atlantic may be affected by the vicissitudes of the Arctic ice. Secondly, when we are considering the spread of vegetation (especially trees) following the retreat of the Scandinavian and British ice, it must be remembered that once established after a favourable group of years the vegetation would not only outlast minor fluctuations but would probably itself lead to a secondary amelioration of the local climate as a result of the slight frictional hold-up of air in the summer months. This effect is well known; even in sizable city parks the mean temperature is of the order of 1° higher in summer than that observed at neighbouring rural stations. If we may ascribe to open woodland half the frictional effect arising from the existence of a large city, the rise of the summer mean temperatures at screen level in a windy north-west European location, consequent on the development of open woodland, should be of the order of 0·5° F. compared with those which would prevail if trees were absent.

It would indeed be welcome if botanists could tell us how many "favourable" years would be needed to initiate a widespread change in the character of the vegetation, sufficient to persist through short unfavourable spells in subsequent decades.

The Allerød oscillation and the subsequent climatic recession

Quite the most remarkable climatic fluctuation with whose dimensions we are broadly acquainted is that amelioration followed by recession which occurred from approximately 10,000 to 7850 B.C. We have the evidence from the Windermere sediments [1] that this event was contemporary with a similar climatic oscillation in southern Scandinavia and it must be correlated with a like oscillation in the Isle of Man and Ireland. During this phase tree-birches extended rapidly northward from Holstein to Southern Norway and from southern England at least to southern Scotland. Accepting the view that for such trees to survive the mean temperature must exceed 50° for at least $1\frac{1}{2}$ months we may draw the isotherm patterns for the Zones II (Allerød) and III ("Pre-Boreal") of the pollen-analysts (Fig. 3). Note that over most of Britain there was, during this "Pre-Boreal," a return to sub-arctic conditions for a period of the order of 400–500 years (8500–7850 B.C.) during which the tree-line and the corresponding isotherm of 50° for July retreated roughly to the line shown on the map.

We cannot equate this Allerød oscillation with changes in the extent of

[1] Winifred Pennington, "Lake sediments . . . Windermere," *Phil. Trans. R.S.* 233B (1947).

land and sea; but we can observe how the retreat of the 50° isotherm is commensurate with that which we now know to exist between groups of windy cool summers, and fine anticyclonic summers; a difference of the order of 3° to 4° (compare Fig. 2). Let us therefore accept that the amelioration was the result of a predominance of weaker circulation, slow-moving anticyclones, or "low zonal index."

Moreover it is evident [1, 2] that there were minor fluctuations within the Allerød phase, all of which accords with our reasonable requirement that from time to time the amelioration was interrupted by spells of windy and chilly summers resulting from "more vigorous atmospheric circulation" or Willett's spells of "high zonal index."

The recession following the Allerød phase is quite well documented as to

Fig. 3. Suggested isotherms for the Allerød phase and succeeding recession

temperature. Movius quotes from Grahame Clark an average for July of 8° C. for coastal Denmark in this "Pre-Boreal" phase ("Zone III"). At Windermere the absence of tree birches, which were still found in south-east England, suggests a sea-level July mean of the order of 47°, and solifluxion-layers are found in Wicklow (Ballybetagh, 750 feet) overlying earlier mud-deposits. On an extensive scale this is a difficulty, unless the mean annual temperature is close to 32°. If for this altitude in Wicklow we assume a July mean of 44° the January mean should be of the order of 20°, remembering that in Britain the annual mean is in general about 1·2° lower than ½(January+July); moreover this is in keeping with the distribution of land, sea and snow-cover. For similar reasons it would lie below 17° in Denmark so that

[1] H. Godwin, "Pollen analysis and Quaternary geology," *Proc. Geol. Ass.* 52 (1941) 328–361; "The Late-Glacial Period" *Science Progress*, 138 (1947) 185–192.

[2] H. L. Movius, 'The Irish Stone Age,' Cambridge, 1942, p. 18.

in Zone III times, allowing for the distribution of land and sea, a value of the order of 18° to 20° for January in south-east England would be acceptable, with 51° to 52° for July to allow for the trees. South Cornwall is more problematical; winter would probably be very variable, depending on the prevailing wind direction and sea temperature. From 34° in the Allerød down to 28° in the subsequent recession would not be out of keeping with the inland estimates; hence my entry of ±31°. Note that the suggested range between July (52°) and January (19°) in the Thames valley is slightly above that now found at Utrecht, in keeping with the absence of a wide North Sea and a "vigour of the circulation" broadly similar to the present day, but with more winter snow-cover.

The above values are based on the probable trend of isotherms in relation to the open Atlantic and the need to assume a disturbed climate, much as we have to-day but with a considerably colder sea.

These deductions with regard to the Allerød phase and the Pre-Boreal are supported by the evidence of the extent of glaciation. Given, during the post-Allerød recession (Zone III) a July sea-level mean of 47° at Windermere, the June–September mean would be likely to fall between 44·5° and 45°. At this stage we can begin to make use of Ahlmann's curve [1] relating snowfall and mean summer temperature at the firn-line in central Norway, which I think would reasonably be applicable in glacial times to the similar rather cloudy maritime climatic conditions in Britain.

From it we may deduce that in a region where the water equivalent of the prevailing snow accumulation amounted to 70 inches (175 cm.) the firn-line, or climatological snow-line, would be found at the level where the mean temperature for June–September is 36·5° F., in round figures 2500 feet for that period and place. This implies a July mean between 2° and 2·2° higher, say, 38·6° F. Under such conditions of temperature, with precipitation abundant in every month of the year as it obviously would be, it is a reasonable assumption that at the snow-line four-fifths of all precipitation would fall as snow. Hence, for annual accumulation of the above amount, the total precipitation should attain 85 to 90 inches. But if the total were 125 inches, with 100 inches as the equivalent of the snow accumulation, the snow-line would be lowered by fully 500 feet. Correspondingly, with a total of 65 inches, it would be raised by a similar figure.

Present-day annual totals on the Lake District mountains range from 70 to over 150 inches. Even if the air were considerably colder, by analogy with Iceland, South Greenland or South Georgia, orography would still operate very effectively; and we may also note how widely the ice spread from our small mountain districts. On balance it may fairly be assumed on meteorological grounds that a 70-inch water equivalent for the accumulation was effective in regions where the annual precipitation now exceeds 100 inches. And, inasmuch as even higher values would prevail, then as now, on Snowdon or round the head of Borrowdale, the snow-line in North Wales and the Lake District would locally be as much as 500 feet below the regional value.

We thus reach the conclusion that in this Pre-Boreal period the snow-line

[1] H. Wilson Ahlmann, "Glaciological research on the North Atlantic coasts," *R.G.S. Research Ser.* 1, London, 1948.

lay at about 2000 feet in the Central Lake District, sufficiently low to provide the small glaciers of whose existence there is evidence in the Windermere sediments and in the conspicuous moraines between 500 and 700 feet at the head of such valleys as Langdale and Borrowdale.[1]

During the Allerød phase (Zone II) the snow-line might be expected to lie about 1000 feet higher; in accordance with the higher summer temperature. Snowbeds would therefore be found among the higher summits in the Lake District, but no glaciers. My estimate of 1000 feet implies that, while the July mean was over 4° higher in the inland valleys during the Allerød, the inland winter mean would be quite as low during the Allerød as during the subsequent recession, if we assume that this was due to the predominance of weaker atmospheric circulation. There would be a greater annual range; and the June–September mean during the Allerød would not be more than about 3½° above that of the cooler phase, allowing the firn-line to rise by 1000 feet on the assumption that the overall precipitation remained similar in quantity. If the Allerød phase was on the whole drier, the firn-line in the central region of the Lake District might have lain as much as 1200 feet higher than during the subsequent climatic recession.

Farther north the post-Allerød climatic recession is correlated with the Perth Readvance, and with the Athdown glaciation in the Wicklow mountains. In relation to events at Windermere it is reasonable to adopt a July sea-level mean of 45° in the Ben Nevis district and a resultant snow-line at 1900 feet for west-central Scotland; locally in the regions of exceptionally heavy snowfall it might be 500 feet lower. This will suffice to provide the necessary glaciation, and it is moreover low enough for the existence of small corrie-glaciers in the Southern Uplands. I have made no allowance here for isostatic recovery, but this is small and does not affect the general principle.

In order to provide for these sea-level temperatures and precipitation it is necessary to postulate a sea-surface temperature, in the ocean west of Scotland, of the order of 45° in late summer during both phases. It may be added that on these assumptions with regard to temperature and precipitation, the firn-line in North Wales at the time of the Perth Readvance would lie at about 2900 feet generally, and over the small areas of heaviest precipitation it might, as we have seen, be as much as 500 feet lower. Hence there should be evidence of a minor mountain glaciation in North Wales at this period, but not south of Cader Idris. On Plynlimon and the Brecon Beacons there would be snowbeds, but not glaciers. Here is a test of potential value. The last small moraines on the Brecon Beacons *ought* to be correlated with the Scottish Readvance and not with the Perth Readvance, unless the precipitation was very much heavier than it now is.

The fall of the snow-line with increase of latitude

An interesting relationship holds at the present day. From a recent examination[2] of the theoretical height of the snow-line in regions of high precipitation in Western Europe I concluded that the rise with latitude is approximately linear from the Faröes to northern Spain. Now it has long been

[1] A. Raistrick, "The glaciation of Borrowdale," *Proc. Yorks. Geol. Soc.* 20 (1923–26).
[2] Manley, *op. cit.* (1949).

recognized that the predominant supply of snow comes from the maritime-polar air masses and in the Ice Age it came, as it does to-day, largely from the west. If we adopt Willett's view that the governing factors varying the pattern of the atmospheric circulation were the same in glacial times as to-day, we merely have to lower the temperature of the dominant air mass; and we can assume that as regards the snow-line a linear relationship would in general still prevail. Such a relationship is supported by the level of glaciation indicated by Flint [1] for the Sierra da Estrella (where the summits reach 6500 feet) in Portugal.

If this roughly linear relation holds for the snow-line during the Ice Age in Britain, it leads to interesting and very satisfactory conclusions with regard to the climate.

Climatic requirements at maximum glaciation

Let us turn to the period of maximum extent of the last glaciation in Britain. I shall not enter into controversy here but it would be convenient to

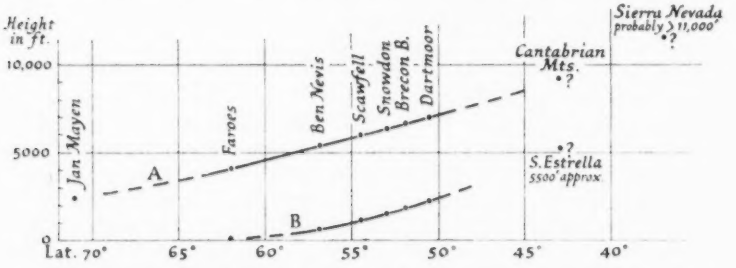


Fig. 4. The southward rise of the snow-line, present (A) and glacial (B)

assume that the Old Drift glaciation represented an early stage of the Würm and that in many areas it coincided with the maximum.

In order to survey the climatic conditions I am basing my findings on those given by Dr. Brooks,[2] in conjunction with the estimate given by Clement Reid which he quotes, that at maximum glaciation the mean annual temperature in East Anglia was 20° below the present value. On the ground of the extent of land and sea, Brooks gives the July mean as 13° lower, January 18° lower and the annual mean 16° lower than the present-day value (which we can take for Cambridge as 49·5°). Brooks' calculation would therefore indicate an annual mean of 33·5° in that region, Reid's inferred value being lower.

We must also allow for the geologists' demand for frozen subsoil. I think there is much reason to assume that in glacial times the summer was very cloudy. Recent data [3] go to show that in climates with a relatively cloudy summer, *e.g.* near the south coast of Alaska, it is possible to have *tjaele* with

[1] R. F. Flint, 'Glacial geology and the Pleistocene epoch,' New York, 1947.

[2] "Continentality and climate," *Q. J. R. Met. S.* 44 (1918) 266; 'The evolution of Climate,' London, 1922.

[3] S. W. Muller, 'Permafrost', Ann Arbor, 1947, pp. 4–6.

an annual mean of 30° F., slightly higher than was formerly thought; Zeuner [1] for example quotes −2° C. or 28½° F. Nevertheless we must adopt an annual mean appreciably below 30° for some distance south of Cambridge and, if we take Brooks' difference between January and July as applicable, we get July 45° and January 15° as reasonable values for south-east England, with an annual mean between 28° and 29°.

It is very necessary not to exaggerate the winter cold in Britain in glacial times. Not only was there open sea quite near the Hebrides but the strong tides in the Channel gulf would keep those waters open, like the seas off Nova Scotia. Even in winter open salt water must have been found close inshore, a good deal of air found its way from the Mediterranean, and it is evident that many icebergs melted in the region of the Scillies. Moreover the botanists want some ice-free areas in the Outer Hebrides.[2] Here there was undoubtedly a heavy winter snowfall, but the prevailing wind must have been from southerly points and an analogy may be sought in south-west Greenland where, adjacent to a sea with much drift ice in it, Nanortalik had (1895–1925) a January mean of 23°. It is to be remembered that the sea must have been partly open as far as Lofoten [3] and that even in Iceland some ground remained unglaciated.[4] In the endeavour to provide low enough temperatures to satisfy the geologists, let us therefore adopt the "principle of least work."

Further, in the light of recent views on the meteorology of ice-caps, I surmise that the climate during glaciation in Britain was much more cloudy and disturbed than some have formerly thought. It is evident from work on the Greenland ice-cap [5] that the air sweeps at intervals right over a plateau 10,000 feet high, and that any surface inversion thereon, however cold it may become, is relatively shallow. In Britain, with a much lower altitude, the air from an open sea would give rise to widespread cloud at all seasons and this might well remain very persistently below a strongly defined inversion; especially in summer when the air flowing over the thawing snow would always be near saturation. Such effects would be more marked whenever depressions made their way into the Norwegian Sea; and it is evident that they did from the precipitation requirements in Scandinavia. Undoubtedly we should place an "Arctic front" just south of Iceland. Mannerfelt's views on the wasting of the ice-cap also imply that, at a later stage, air from the Atlantic would sweep right over Scandinavia.

Let us now turn to the requirements in the Hebrides. I have recently considered the annual number of days of snow-cover on unglaciated rounded summits at the level of the firn-line in windy countries such as Scotland and Norway.[6] It appears to be about 265 days, and in wet maritime climates this frequency might be expected to occur at an altitude where the mean July temperature is about 39°. Indeed summits free from snow for a short period

[1] F. Zeuner, 'The Pleistocene period,' London, 1944.
[2] J. W. Heslop Harrison, "The passing of the Ice Age," *New Naturalist* (1948).
[3] E. Dahl, "Unglaciated areas in Norway," *Norsk Geogr. Tidskr.* (1947).
[4] S. Thorarinsson quoting T. Einarsson in *Geogr. Ann.* 31 (1949) 251.
[5] F. Loewe, "The Greenland Ice Cap . . ." *Q. J. R. Met. S.* 62 (1936) 359.
[6] Manley, *op. cit.* (1949).

may be found 1000 feet above the neighbouring climatological snow-line (as at Fanaråken). Hence unglaciated uplands in the southern Outer Hebrides at 1500 feet might well be found with a sea-level mean of about 40° to 41° in July; while, the situation being very near to an open and very stormy sea, a January mean of 23° would be acceptable. All this implies a January–July range approaching that of the present day in the Outer Hebrides; also, from the July mean temperature, a firn-line would be found in the wetter districts of western Scotland at an average altitude of 400 to 500 feet above sea-level.

Thirdly, we have the presence of the tree-line in northern France, indicating an average temperature over 50° in July.[1] Fourthly, it is absolutely necessary to have a very heavy snow precipitation, involving vigorous atmospheric circulation and much wind on our mountains; and, fifthly, a relatively warm sea not far off Cornwall. Hence the January mean on the extreme south-west of Cornwall could not lie far below freezing, perhaps 24°, while we might estimate 46° for July. Given the open warm sea to the south and a fringe of colder surface water, south Cornwall would have a foggy and cloudy summer climate like parts of south-west Alaska today. If we put together these values for south-west, south-east and north-east Britain we get a pattern of isotherms and of temperature gradients bearing a relation to the coastline similar to that which we find to-day; the numerical difference arising from the presence of a much colder sea.

I find it difficult from the climatic standpoint to allow for any perennially frozen ground near sea level west of Somerset. On the other hand the existence of frozen subsoil well into north-eastern France in the region of Amiens is acceptable, allowing for the chilling effect of the icy southern North Sea in summer. The *loess* at a little distance inland can also be explained as the result of the rapid warming and resultant turbulence in the strong cool north-easterly winds of spring and early summer.

There is a further clue to the temperature of south-east England. If we require nivation-hollows at 300 feet above sea-level on the South Downs we may point to the evidence [2] that, for snowbeds to persist through the summer in sheltered locations with a cloudy maritime climate, the mean temperature of June–September should not exceed about 42·5°. This implies that July should not exceed 45°, or 46° at sea-level; such a value is in keeping with our other findings.

Under conditions of heavy precipitation (about 80 inches per annum, and assuming Ahlmann's curve to apply) the snow-line in Sussex would lie at about 2000 feet; with lighter precipitation (about 40 inches per annum) it should reach 2600 feet, a figure also given by Penck for this region.[3] Farther west in the Dartmoor region with undoubtedly a much heavier precipitation, probably comparable with the present value of 80 inches per annum, the snow-line must nevertheless have lain close to if not above 2000 feet as glaciers did not form, or if they did they were small and extremely marginal. This again places our sea-level July mean in Cornwall close to 46°.

[1] Compare the map in Zeuner, 'The Pleistocene period,' p. 64.

[2] G. Manley, *Geogr. Ann.* 31 (1949) 179.

[3] H. Louis, "Glazialmorphologische Studien in den Gebirgen der Britischen Inseln" *Berliner Geographische Arbeiten* (1934).

With the above estimates of mean temperature, in south-east England nivation-hollows and frozen subsoil would certainly be found during the "Older Drift" phase; during the "Newer Drift" they might not occur so far south. But we must not lose sight of the local cooling effect in summer of the "ice-lake" in the southern North Sea which might assist the southern extension of such phenomena. In drawing up estimates for winter mean temperatures, it seems to me inherently probable that the range would increase as the ice-sheets diminished; summer temperatures in our latitude would rise in the south more rapidly than winter temperatures, although the latter would rise also because of the more open Atlantic. In Cornwall the winters would probably be very variable.

We have thus two reconstructions for the Perth Readvance (correlated with the Pre-Boreal Zone III) and the Older Drift. Figure 5, simplified from one by Movius, illustrates the extent of the several phases of the retreat. From "Perth Readvance" to "Older Drift" we have lowered the temperature by a mere 5° or thereabouts, little more than that between the Climatic Optimum and to-day's cooler phases. We have brought the snow-line in west-central Scotland from 1900 down to 400 feet or so. That implies a lowering from 2500 feet to perhaps 1000 feet in the Lake District and from 2900 feet to about 1400 feet in North Wales. From Ahlmann's curve we have deduced that locally in the small central areas where precipitation is very high, the snow-line would be lowered by a further 500 feet or thereabouts. If we assume that the snow-line rose to the southward in the same manner as to-day in regions of comparable precipitation, we can arrange very neatly for the glaciation of the Brecon Beacons and we shall only barely avoid the glaciation of Dartmoor. I have tried to show this in Figure 5. Note the rough parallelism of the south-easterly margins of the ice and the present-day July isotherms along the north-west coast.

Eastward from the Lake District and North Wales, although in a cloudy windy climate the summer mean temperatures would be much the same, the snow-line would become steadily higher on account of lower precipitation. For the Lake District my calculations are based on a water equivalent of 70 inches for the accumulation; if we bring this down to 55 we raise the snow-line by about 500 feet. This implies that with a snow-line at 1400 feet in North Wales (and 900 feet locally on Snowdon), the Derbyshire Pennines south of Kinderscout might just remain unglaciated, there being insufficient gathering-ground at the requisite altitude; but a very slight variation in the accumulation farther north would suffice to cause ice to override some of the cols.[1] Similarly we might just satisfy Dr. Raistrick's evidence [2] for a glacier in Weardale, with adjacent summits not quite permanently covered by snow, on the assumption that the relative amounts of precipitation were similar to those of to-day. Certainly the summit of Ingleborough (2373 feet) might be left unglaciated, while even that of Crossfell (2930 feet) could just be allowed to remain unglaciated without straining the estimates, either of temperature or pre-

[1] A. Jowett and J. K. Charlesworth, "Glacial geology of the Derbyshire dome and the western slope of the Southern Pennines," *Q. J. G. S.* 85 (1929).

[2] A. Raistrick, "Late-glacial and post-glacial periods in the north Pennines," *Trans. Northern Naturalists Union* (1932). See also *Proc. Geol. Ass.*, 1931.

Fig. 5. The phases of glacial retreat

Table 4—Estimated July and January means at sea-level, on a climatological basis (° F.)

Stages:	*A*	*B*	*C*	*Allerød*	*D*	*Present day*
Outer Hebrides ..	40–23	40–23	42–25	46–25	44–25	56–42
Ben Nevis	40–15	40–15	42–17	48–17	45–17	57–39
Lake District (inland)	42–12	43–12	45–16	52–17	47–17	60–39
Kent–Sussex (inland)	45–15	47–15	49–17	54–19	51–16	62–39
South Cornwall ..	46–24	46–24	48–28	53–31 ±	49–31 ±	61–45

Estimated average altitude of the climatological snow-line or firn-line (in feet)

Ben Nevis .. ±	400	500	1100	2900	1900	(est. 5300)
Lake District .. ±	1000	1100	1700	3500	2500	(5900)
Snowdonia .. ±	1400	1500	2100	—	2900	(6300)
Brecon Beacons ±	1750	1850	2450	—	—	(6650)
Dartmoor .. ±	2100	2200	—	—	—	(7000)

Notes

Snowbeds would probably persist on the South Downs in (A), and a few might persist during (B).

Primary assumption: 85–90 inches precipitation at firn-line, four-fifths snow.

Variation within hilly regions for greater or less precipitation ±500 feet.

Basis: Ahlmann's curve.

cipitation[1]. Linton has demonstrated that Tinto Hill was not an independent centre of glaciation.[2]

Let it be noted however that we do not know the exact precipitation. Assuming a degree of atmospheric disturbance similar to the present day and rather cooler air, with four-fifths of the precipitation at the firn-line falling as snow, it does not seem unfair to expect that the total annual precipitation would at least exceed 80 inches in those regions where to-day it exceeds 100. At a later stage it may be possible to calculate the precipitation necessary to balance the ablation at various stages of glaciation.

We must provide a disturbed climate with heavy precipitation in order to explain why the ice spread so far from relatively small gathering-grounds. Further it will be noted that over the northern Irish Sea the surface of the ice sloped very gently southwards; and over much of northern England, in the Eden valley for example, the surface of the ice at maximum lay above the firn-line which I have proposed. Hence, once the ice had attained a certain thickness the area of accumulation would be greatly increased and the advance would be more rapid.

If the temperatures in Table 4 are correct and we have erred in regard to precipitation, there being less than we have assumed, there the firn-line will have to lie considerably higher and it will scarcely be practicable, for example, to provide for a supply of ice from the resultant small gathering grounds to fill the whole of the Irish Sea. On the other hand, if the temperatures were lower, it is not easy to allow for the survival of plants in Lofoten, or even perhaps in the Ponder's End flora. And, if winters are colder it is difficult to have an open sea. I therefore offer the above values, as representing the best fit for all the data, for the late-Glacial climate of Britain.

The varying spread of the Scottish Readvance and Newer Drift suggest intermediate mean values for the summer temperature and for the altitude of the snow-line at those periods; in particular recent views [3] on the glaciation of Cumberland during the Scottish Readvance can be met. Each standstill or slight readvance of the ice is clearly attributable to a climatic recession giving cooler and more cloudy summers. Since I wrote this paper I have found two references supporting these findings. In 1934 H. Louis [4] gave values for the snow-line in close agreement with all the above data, largely based on the work of Charlesworth. In particular Louis thinks that the difference in the snow-line between Older and Newer Drift should only be of the order of 150 to 300 feet, with which I agree. The only marked difference lies in South Wales where, if Louis is right, the snow-line may have lain 300 feet lower than my estimate. This either points to the precipitation in South Wales being rather greater than now, quite in keeping with the local geography, or to a lower sea-level. Tolerances might be put at $\pm 1°$ for July and $\pm 2°$ for January (and therefore ± 300 feet for the snow-line) bearing in mind the consequences of the lower sea-level. It has already been shown that in each mountain district there would also be differences of this order between the

[1] F. M. Trotter and S. E. Hollingworth, "The glacial sequence in the north of England," *Geol. Mag.* 69 (1932) 374.

[2] D. L. Linton, *Geol. Mag.*, 70 (1933).

[3] Raistrick, *op. cit.*

[4] Louis, *op. cit.*

Normal Extent of Pack
Present Extreme Limit of Pack
Norwegian Sea : uprising of warm salt water in centre to replace sinking at borders beneath ice? Cf Baffin Bay. Lofoten not (North Greenland today, ie July 38°, South Iceland not completely glaciated, hence course of 40° July isotherm.
Scandinavian Ice Cap
40° July
Border of Land Ice
50° July
Loess Zone
Forest Zone
16° January
24° January
Present Extreme Limit of Pack
Cold West Wind Drift
Present Extreme Limit of Drift Ice
Approx. Limit of Pack Ice in Ice Age?
Ice Age: Estimated Convergence Zone and Polar Front
Warm Salt Water Drift
Ice Age: Extreme Limit of Drift Ice?

Fig. 6. Glacial conditions in the Atlantic

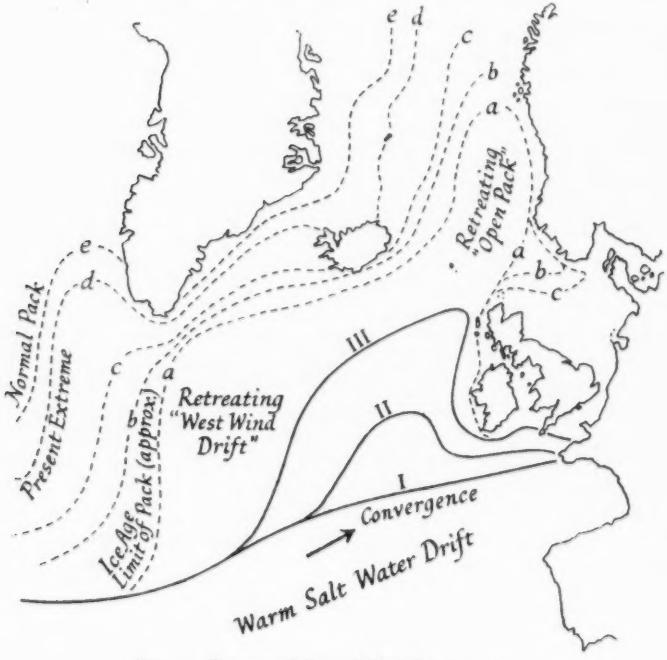


Fig. 7. Suggested Late Glacial sequence

wetter and drier areas. With regard to the Brecon Beacons I think the effect of a rather lower sea-level is indicated, rather than a great increase in precipitation, because at best we can only have the minimum of glaciation on Dartmoor and there is only a narrow margin in which to fit the two cases. Moreover there is evidence for a lower sea-level.[1]

A climatological estimate for the extreme south-west of Ireland may be interposed in view of its relevance to the problem of the Lusitanian flora. Assuming that close to the warmer sea the snowfall would be exceedingly heavy, the firn-line might, with the same mean temperature, be decidedly lower on the Kerry mountains than elsewhere. Given a favourable slope adjacent to the sea it might be possible, on the preceding assumptions, to provide places which at maximum glaciation had a July mean of 48° and a January mean of 31° (a little cooler than western Tierra del Fuego to-day); whether this will satisfy the botanists I do not know. At the same time, with an assumed precipitation of 150 inches it follows from Ahlmann's relationship that the firn-line under those temperature conditions would be brought down to 1900 feet on the Kerry mountains, allowing for abundant glaciation.

Finally Figure 6, which is based largely on Flint's, Simpson's and Brooks' ideas, will serve to illustrate the concept which one may offer to illustrate the variations in sea-surface temperature during the waning of the last glaciation.

Since I wrote this paper I have also received, quite by chance, two very recent German papers by H. Poser.[2] His distribution for the limits of frozen ground, for trees and for types of climate is most satisfactorily accordant, although he offers no very definite estimate of the winter temperatures in southern England. In particular he derives his overall estimates from an assumption (after Taber) that permanently frozen ground requires an annual mean as low as 26°, whereas a higher figure now appears to be permissible, as we have already seen.[3] Poser's views have recently been summarized, with diagrams, by Schwarzbach,[4] and are indispensable in a discussion of the glacial climate of Europe.

Conclusions

It is very evident that small changes of temperature in our maritime climate are capable of giving rise to widespread effects. Lowering or raising the summer mean by 2° or 3° F. can account for each of the principal vicissitudes during the retreat from maximum glaciation. Such rises or falls are of the same order of magnitude as those which accompany the phases leading up to, and succeeding, the Climatic Optimum and are susceptible of similar explanation.

The temperatures for January and July given for the retreat stages represent the best fit with the available data and can be claimed as "inherently probable." It seems to me likely that in Britain the annual range of mean

[1] A. Farrington, "The level of the ocean in glacial and late-glacial times," *Proc. Roy. Irish Acad. B*, 50 (1945) 237.

[2] H. Poser, "Daurfrostboden und Temperaturverhältnisse während der Würm-Eiszeit," *Naturwissenschaften*, 34 (1947) 1–9; "Auftautiefe und Frostzerrung im Boden Mitteleuropas . . ." *ibid.* 35 (1948) 232–238, 262–267.

[3] Muller, *op. cit.*

[4] M. Schwarzbach, 'Das Klima der Vorzeit,' Stuttgart, 1950.

temperature is of much the same order, ice or no ice, and, on the ground of "best fit," one is forced to the conclusion that under glacial conditions the distribution and amount of precipitation cannot have differed greatly from that of to-day. In the peripheral regions however there may be some support for a locally greater precipitation than now, but not so much greater that the firn-line would fall below 1500 feet in Derbyshire or on the Brecon Beacons.

If the annual range of mean temperatures and the associated vigour of the atmospheric circulation lie within the limits that we now experience, the general circulation has undergone changes in vigour of the same order, with little or no relation to the characteristics of the underlying surface. In regard to the surface temperatures, the principal variable may thus have been the sea-surface temperature of the North Atlantic. The waning of the Ice Age is associated by Mannerfelt with increased transport of relatively warmer air from the ocean over the Scandinavian ice [1]; on the other hand the minor glacier advances and the post-Optimum recessions are associated with increased transport of relatively cool oceanic air.

Under whatever term we consider this increased transport—whether in relation to Willett's views, or those of Ångstrom—we appear to be asking from time to time for out-of-phase variations in the ocean surface temperature. Moreover we have to consider the opening of the "gulf of warmth" in the Boreal phase, when the prevailing sea temperatures rose by something like 10°. The magnitude of these climatic variations, represented by the stages of retreat and attributable to changes in the vigour and pattern of circulation, is the same as that of the variations in the post-Glacial save that the sea was colder. Why then did the sea become warmer at a time of excessive melting? Does the answer lie in the steady decrease in the periphery of the ice?

I offer it for consideration that in addition to variations of the vigour or pattern of the atmospheric circulation we must still look for agencies capable of causing independent variations in the sea-surface temperature of the North Atlantic; or at least variations with a marked difference in phase from those of the air. The interpretation I have offered in Figure 6 is indeed tentative, but I hope that it will serve to interest oceanographers in these problems of climatic variation for which we appear to have a partial meteorological explanation in Willett's recent papers.

Finally, as all the evidence from before the Climatic Optimum as well as after it goes to show that climatic ameliorations of greater or less length have all been terminated by recessions, we ought not to expect the minor improvement apparent in the past twenty years necessarily to continue. To judge from past variations in the decadal mean temperatures we can yet go further in the direction of warmth, but past experiences of the duration of such minor swings indicate that we must be very cautious in our expectations. Into the possible reasons for a sudden and widespread fall in sea surface temperature we cannot enter here. But it may be desirable to consider when and why it began to rise; was the rise initiated as early as 1910? and will, for example, Sir Gilbert Walker's [2] detection of a change in the relationships between the

[1] Mannerfelt, "Some glacio-morphological forms," *Geogr. Ann.* 27 (1945).

[2] G. T. Walker, "Arctic conditions and world weather," *Q. J. R. Met. S.* 73 (1947) 226.

extent of Newfoundland ice and the Arctic pressure distribution prove to be a guide?

There is still much need for the observation of contemporary changes that may throw light on past climatic history. In this effort to link some results of present-day observation in several sciences with past events, I am conscious of the numerous assumptions it has been necessary to make, some of which may be regarded as argument in a circle, while others may not stand the test of time. But as a preliminary estimate of the amplitude of our climatic fluctuations, great and small, I hope it will draw attention to the need for further field work.

Postscript

Three recent climatological papers published in the *Centenary Proceedings of the Royal Meteorological Society* (1950) must be noticed. Professor Faegri therein provides a salutary reminder of the difficulties and risks in the interpretation of all types of palaeoclimatological evidence. But he doubts if any of the Quaternary fluctuations had a greater amplitude than the differences between individual years; with this view my estimates are in full agreement. Professor Willett has already expressed the view that the shorter fluctuations follow a pattern almost identical with the Glacial-Interglacial fluctuation and that the amplitude of the fluctuations increases with their length; Faegri disagrees, considering that the longer the period the more complete the reaction of all its indicators, so that a long cycle affects a wider area. For the present minor fluctuation, Willett cites evidence of the intensification of the poleward continental anticyclones as an important change in the general circulation and thinks that the prevailing rise in temperature began about 1885. From his own detailed and world-wide investigations however, Dr. Lysgaard shows that the rise in temperature has been by no means uniform.

Mention should also be made of evidence provided by Conolly, Godwin and Megaw [1] for relatively temperate conditions in Cornwall during the Allerød phase; that solifluction subsequently occurred is noteworthy, but I do not think it is yet necessary to invoke permanently frozen ground.

SUMMARY OF THE DISCUSSION

Afternoon Meeting 23 January 1950

Professor GORDON MANLEY was introduced by the Chairman (Professor J. A. STEERS) and after he had read his paper a discussion followed.

Sir NELSON JOHNSON (Director, Meteorological Office) pointed out that the fluctuations in temperature between comparable years were greater than the amelioration of the past thirty or fifty years. This change is itself significant and, in regions that are on the threshold of agriculture or faunal life, a few degrees may make a big difference; it was interesting to consider the equivalent change in latitude as well as the equivalent change in altitude, which Professor Manley had shown to be about 250 feet. For certain fish, such as the cod, the change we are now experiencing may cause migrations of considerable economic consequence.

The present fluctuation affords an opportunity for studying the mechanism

[1] "Late glacial deposits in Cornwall," *Philos. Trans.* 234B (1950).

of climatic change in greater detail than has previously been possible. It would be instructive to study the simultaneity, or non-simultaneity, of such changes in different parts of the world so that the lag in phase of changes in different parts of the atmosphere may be detected. In north-western Europe the shrinkage of glaciers is attributed to increased circulation and a rise in temperature, but the shrinkage of the East African glaciers is attributed to a decreased precipitation; two different explanations for the same phenomenon.

Dr. C. E. P. BROOKS also pointed out that the change from year to year was much greater than the decadal change; it was not impossible that these progressive changes were due to the accumulation of the irregular changes from year to year. He considered that the direct cause lay in the great diminution of Arctic ice in the past half-century. Before 1900 the coasts of Iceland were blocked for perhaps two years in three whereas he did not think that there had been any ice off the Icelandic coasts in the last twenty years. There had been a similar change in Spitsbergen. He said that he had recently had in mind the idea of two possible modes of atmospheric circulation; one with a small ice-cap and a high-index circulation, the other with a large ice-cap and a low-index circulation. Both modes might be stable and short fluctuations of climate might result from a jump from one mode to the other. He was glad that the speaker had considered the question of ocean temperature; this, and its stratification in the ocean, was possibly one of the important factors.

Professor HOLLINGSWORTH (University College, London) asked whether in referring to frozen ground in glacial times, the speaker envisaged ground frozen to a depth of 10 or 15 feet, or, as he as a geologist thought more probable, ground frozen to a depth of 100 or 200 feet as it is in Siberia.

Mr. C. D. OVEY (British Museum, Natural History) referred to work in which he was engaged on the foraminifera from the deep sea cores of the *Albatross* expedition; from them it should be possible, eventually, to interpret some of the past changes in ocean temperatures.

Dr. SUTCLIFFE (Meteorological Office) approached the problem from the point of view of the synoptic meteorologist. The relationships between the factors involved could no doubt be represented by differential equations but the equations must at present remain insoluble except by processes of approximation. The approximations would depend on whether the fluctuation to be considered had a period of a few months or a million years. For short period fluctuations one could certainly ignore variations in the polar ice. He doubted if, even for decadal fluctuations, the amount of ice-cover was significant. For still longer periods the main oscillator might well be ocean temperature; and for thousands or millions of years something with a very high degree of inertia—the bulk of the polar ice. He considered that in the fluctuations which Professor Manley had described all these oscillations were going on more or less independently.

Mr. W. V. LEWIS (Cambridge) was interested in Professor Manley's interpretation of the varying height of the snow-line in Glacial and post-Glacial times and its application to small moraines in the Lake District and the Brecon Beacons.

Mr. E. GOLD said he had expected the speaker to lay more emphasis on the different effects of a rise in temperature over the ocean and over a continent; the former would probably result in more precipitation and the latter in less. General conclusions could not safely be drawn from a study of temperatures without taking into account the consequent changes in precipitation.

Professor AUSTIN MILLER (Reading) made the point that certain fairly sensitive plant indices might be used as evidence of climatic change, and climatic change might explain fluctuations in the production of crops.

Professor SHEPPARD (Imperial College) thought it as important to study the spatial as the temporal aspect of climatic fluctuation. Are we to explain climatic surges in one area by recessions in another, or are the surges world-wide? He agreed that the problems were ultimately amenable to a physical solution but it had also occurred to him that they might be essentially an instability phenomenon. A cumulus cloud growing into cumulo-nimbus was such an instability phenomenon and so, on a large scale, was a depression in middle latitudes; we knew that in a given situation depressions were likely, but it was difficult indeed to say where the next would occur. Climatic variation might be similar again, but on a still larger scale. This seemed the more likely because ice and snow change the processes of radiation so radically.

Professor HAWKES (Bedford College) thought that some of the geological evidence of frost phenomena might require lower temperatures than the speaker had allowed. It was possible that his estimates were right for the general run of post-glacial temperatures but there might have been considerable fluctuations to lower values.

Mr. H. H. LAMB (Meteorological Office) asked whether estimates were available for the variation in the extent of the polar ice cover, from year to year or over decades or centuries, as that factor seemed to be involved in the corresponding climatic fluctuations. He was surprised at the high precipitation which Professor Manley had postulated for the British Isles during the Ice Age. In Spitsbergen and Greenland, whose present situation might be comparable, the precipitation was far less. He also alluded to recent work of his own on the regular recurrence of singularities of weather from year to year; these seemed to have persisted through such climatic fluctuations as had occurred since the fifteenth century.

Mr. G. A. A. GRANT asked whether anything was known of corresponding temperature changes in the Polar seas and on the north Canadian coast.

Mr. D. J. SCHOVE mentioned the possibility of reconstructing, not the isotherms but the prevalent wind directions of glacial times. This had been done in a paper by Poser who relied, he thought, on the accumulation of the *loess*. He asked whether such wind fluctuations could be determined and interpreted in England.

Replying to the discussion, Professor MANLEY said that as a geographer he felt his function was to try to display some kind of integration of the available material; it might yield a bad map, but one that might stimulate inquiry and so prove better than no map. With Sir Nelson Johnson's comment on the significance of thresholds in regard to margins of cultivation he cordially agreed. Icelanders might well wonder whether in future they would need more coal to get the cod although less for domestic use. Dr. Brooks' endeavour to relate the Arctic ice and the vigour of the circulation appeared very promising, though at times it might be helpful to have both a high-index circulation and plenty of ice. In reply to Professor Hollingworth he thought that in a climate with a great deal of water about, provided the annual mean remained just below the point necessary for permanently frozen ground, the thickness or depth of the frost layer might increase slowly by conduction from above—to what limits he could not say. He had tried to depart as little as possible from present-day temperatures, not only on grounds of economy but also in order to provide for the botanists' requirements. Mr. Ovey's work held out immense promise, for the ultimate limit for pack-ice should eventually be ascertainable from his findings. Dr. Sutcliffes' "repeated oscillations" appeared to revive ideas which had tended to be eclipsed in favour of sudden jerks and snaps; yet an ultimate oscillation of which we should take account might be imposed by the isostatic

equilibrium of the overlying ice-sheets. He hoped that Mr. Lewis would lead some of his teams in the field to clear up the age of our latest moraines. Professor Miller's reference to the marginal cultivation of certain plants reminded him that there was still room for inquiry regarding the vine in medieval England; so far the evidence seemed to him to confirm that our summers could never have exceeded for long the present mean by three degrees. Professor Hawkes mentioned frost wedges, which are believed to require periods of mean temperature below 14° though it did not appear that these periods need be prolonged. With a mean January temperature of 15° in south-east England, much lower values would occur for two or three weeks at a time, and the scheme he had provided also allowed for very great capacity for variation from year to year. If frost wedges were later proved to have occurred in Devonshire one would have to move the isotherms somewhat farther west, though the principles of distribution would still hold. In reply to Mr. Lamb he thought that the Arctic sea-ice had diminished in area by somewhere about 10 per cent. in the last forty years. With regard to ice-age precipitation on British mountains, he thought the inner Spitsbergen fjords did not provide a good comparison; and under present conditions in southern Greenland where the sea-ice was narrow or absent, Ivigtut had about 50 inches a year and Torgilsbu about 80, even at low levels near the coast. In reply to Mr. Grant, he thought that the Canadian Arctic stations had not yet been in continuous operation long enough to enable close comparisons to be made. Mr. Schove had mentioned Poser's work, which he knew and admired; as yet he could think of no way of adding to wind data beyond what we already knew.

In a written communication, Mr. L. C. W. BONACINA remarks that every year has its own distinctive meteorological pattern which is not repeated either in the distribution of its elements or in the sequence of its weather. He is glad that Professor Manley stressed caution with regard to the present "amelioration" and that Sir Nelson Johnson pointed out that the yearly variation is greater. Because of the persistency of weather phenomena, it should not cause surprise that variations persist for a few years or even for decades. He agrees however with Dr. Brooks that if a trend is long continued it may disturb the whole equilibrium. If the ice caps should disappear there would be no source of enduring cold; the northern continents would be cold in winter but, without the intensely cold Arctic air, they would warm rapidly in spring; in England there would then be little or no spring snowfall. Mr. Bonacina thinks that there is some geological evidence of glaciation on Dartmoor and he would consider this likely from the proximity of the larger ice sheet of Britain.

Professor Manley replies that Mr. Bonacina's comment is very relevant to the tendency, over the last twenty years, for winter temperatures to fall and for spring temperatures to rise; at the same time winter mean pressure has tended to rise over Eurasia. He adds that his own scheme of temperatures is certainly capable of developing a very slight glaciation on Dartmoor; much would depend on the extent to which sea-level was lowered off the coast.

VOYAGING DISTANCE AND VOYAGING TIME IN PACIFIC MIGRATION

THOR HEYERDAHL

IN THE LAST issue of the *Journal* [1] Professor Heine-Geldern defends the hypothesis of a west-to-east migration of aboriginal peoples straight across the Pacific from south-east Asia to South America. This he does, partly by allowing the *Kon-Tiki* expedition to have lent practical support to the feasibility of such long transoceanic voyages in primitive craft, partly by a criticism of some of the culture traits listed by the present writer [2] in support of a movement in the opposite direction. As it seems to have become a choice of theory whether an aggregation of mutual culture traits in geographically separated areas is to be deemed to indicate diffusion, or merely independent evolution along parallel lines, it is relevant to consider first the deductions he makes from the results of the *Kon-Tiki* expedition.

Heine-Geldern's confidence in the mobility of aboriginal man is entirely shared by the present writer, who has for years followed with interest his attempt to establish the diffusionist view that no ocean span is too wide to justify the assertion that it cannot have been crossed by early craft, in one direction or another. But comparative anthropology calls for a practical approach to the problem, a critical analysis and sober definition of how and where, and especially in what direction, the prehistoric transfer could have taken place. On this essential detail Heine-Geldern seems to have very fluid conceptions; I cannot share his implied view of the almost unlimited feasibility of voyages across unsheltered and uncharted oceans in prehistoric craft, and this is indeed the only point on which the *Kon-Tiki* voyage, as such, can contribute new evidence with direct bearing on South American and Oceanic ethnology. It is to go too far to deduce, as he does, that our westward drift from Peru to Polynesia on a *balsa* raft establishes that a canoe must accordingly be able to travel eastward from Polynesia to Peru with the same ease, and thence return to Polynesia again. Our expedition was organized to distinguish fact from theory in the anthropological consequences of a geographical and nautical problem where too many workers had already resorted to theoretical assumptions, and some even to purely speculative and wishful arguments.

Our experience with a replica of the amazing South American balsa raft, and our verification of the strong and natural "ocean escalator" which rolls perpetually from Peru to Polynesia, neither proves nor even indicates that a journey in the opposite direction and in a different craft would have been as readily achieved. On the contrary, our success in crossing the ocean was emphatically due to the geographical location of our starting-point and to that specific type of craft.

The basic results of our investigation were that, contrary to existing theories and assertions, the balsa raft of pre-Columbian South America is among the most commodious and seaworthy craft ever invented by early man and that Polynesia lay within easy range for exploring parties or accidental drift voyagers from early South America in the craft available to them.

[1] *Geogr. J.* 116 (1950) 183–193.
[2] *Geogr. J.* 115 (1950) 20–41.

In 1525 the first huge balsa raft with excellent cotton sail and rigging and a crew of twenty Indians, was captured at sea by Bartolomeo Ruiz, Pizarro's pilot, as he pushed down to the northern Inca waters on his voyage of discovery from the Panama isthmus. The raft was loaded with merchandise from the Inca Empire and its capacity was estimated by the captors to be close on 30 tons. Later, when the Spaniards reached the first Peruvian harbour at Tumbez, a whole flotilla of similar rafts came out to sea to greet them. In the decades following the discovery and conquest of Peru we have many descriptions of these rafts, with their sails and centre-boards, by such well-known chroniclers as Samanos (1526), Andagoya (1541–46), Zárate (1555), Sarmiento (1572), Balboa (1586), Garcilasso (1609), Cobo (1653) and others. Their descriptions agree entirely with the later drawings by Juan and Ulloa (1760), Paris (1841–43), and Humboldt (1810) and with the rafts still used by the coast Indians of north Peru and Ecuador for ocean fisheries and for transport up to the turn of the century. More primitive sketches of such sailing rafts have also been left us by Benzoni (1572) and Spilbergen (1610).

A hundred years ago Byam saw a sea-going Peruvian balsa raft heading for Ecuador with a native crew and cargo; he was told by the captain of his ship that these were excellent craft but restricted to coastal navigation because they had to be dragged ashore to dry in the sun at frequent intervals, as the balsa logs would otherwise become waterlogged and the raft would sink. In publishing this piece of false information, Byam created a most sceptical attitude towards the sea-going qualities of the balsa raft among later scholars, who either quote him or make use of the information. Few competent Americanists have attempted an inquiry into the qualities of the raft or its role in the life of the coastal population of Ecuador and north Peru, or into its use as a merchant-vessel and expeditionary craft in the Inca Empire, often referred to in Inca tradition and history. Lothrop and Means, the two leading anthropologists to devote specific attention to the subject, both came to a negative conclusion as to the raft's quality and sea-going ability. Lothrop,[1] in his otherwise careful and excellent report on the local craft, quotes Byam and thinks that they would not float even long enough for a visit to the Galapagos Islands. Means,[2] referring in part to Lothrop, thought it almost unique in human history that a people like the early Peruvians, who in Inca times had some two thousand miles of coast-line, should have reached an outstanding degree of aboriginal civilization in almost all other respects and yet not know how to build a simple form of watertight and elevated "boat." He felt that a complete failure in seamanship and navigation could be judged from the local absence of any other form of construction than boats of reeds lashed together and balsa rafts.

Hornell [3] also made a thorough analysis of the balsa raft, in an attempt to demonstrate how the American sweet-potato could have reached prehistoric Polynesia with its Peruvian (Quechua) name. He suggested that the transfer must logically have been made by the early Americans, and by balsa raft from Peru. Yet, partly referring to Lothrop, even Hornell is led to make the reservation: "Certainly no ordinary, untreated balsa raft could make a prolonged oversea voyage unless the Inca's seamen knew of an effective method of treating its absorbent logs with some kind of waterproofing composition. . . ."

[1] Lothrop, S. K., "Aboriginal navigation off the west coast of South America," *R. Anthrop. Inst.* 62 (1932).

[2] P. A. Means, "Pre-Spanish navigation off the Andean coast," *Amer. Neptune*, 2 (1942).

[3] J. Hornell, "How did the sweet potato reach Oceania?" *Jour. Linnean Soc. London*, 53 (1946).

The first and obvious result of our actual testing of a balsa raft at sea is not therefore that suggested by Heine-Geldern, but a practical demonstration that the early South Americans did possess a craft of great carrying capacity and buoyancy; and one safer for crew and cargo, both in coastal surf and in deep sea navigation, than any other open craft ever constructed by an aboriginal seafaring nation. Our raft was undermanned for paddling and its crew had never seen one before, nor a *guara* (centre-board). We were therefore entirely at the mercy of the elements but this did not prevent our safe arrival in Polynesia, even when wrecked on an unsheltered reef.

The second implication of our voyage has a direct bearing on Polynesian ethnology, even though the balsa tree, and thus the raft iself, is strictly South American. Any territory that may have contributed to the peopling of the out-of-the-way and ocean-hidden islands of Polynesia must be one in which aboriginal man had developed coastal navigation and a buoyant and seaworthy type of craft. This obvious necessity, and the misconception that balsa rafts were not seaworthy, has made students turn their back on the nearby and windward coasts of America with their prehistoric peoples and cultures, to ransack distant Asia and even other parts of the Old World for possible contributors to the mixed settling of Polynesia. The theories which propound these Old World origins are however as many as they are divergent and contradictory. Heine-Geldern alone has suggested that the Polynesians on Easter Island got their script from Pakistan, its exact antipodes,[1] that their stone adze blades came from China or the Philippines and their religious structures from Assam and Indonesia.[2]

In 1932 Dixon [3] urged that the sweet-potato at least proved a link with early America, and he touched on the possibility that it might have been introduced to Polynesia by some prehistoric Peruvian craft. In the same year however Lothrop denounced the buoyancy and seaworthiness of the balsa raft; and in 1934 Dixon [4] withdrew his earlier proposal with the comment ". . . since we have no evidence that at any time the Indians of the Pacific Coast of South America where the sweet-potato was grown, had either the craft or the skill for making long sea journeys, we are forced to conclude that the transference of the plant was carried out by Polynesians." Dixon, otherwise a most careful and competent scholar, thus spread the Americanists' misconception of the balsa raft into the literature on Polynesia, where it has been quoted by many specialists. Whenever the introduction of Peruvian crop plants or culture elements into Polynesia has seemed apparent, Polynesian writers have therefore felt that the absence of seaworthy craft in South America must prove that the Polynesians themselves had gone all the way to Peru in their canoes, and that the early Americans played no part in the transfer. Through this bias a whole windward continent, with ancient cultures of all patterns and pre-iron stages, has been eliminated from consideration as an alternative contributor to the complex growth of man and culture in Oceania. Its falsity has been fully demonstrated by the *Kon-Tiki* expedition. Other views bringing stone age Asiatics into the eastern Pacific, merely emphasize their theoretical nature by trying to find support in the outcome of that voyage.

Before we leave the practical side of the transoceanic migration problem, we

[1] R. Heine-Geldern, "Die Osterinselschrift," *Anthropos*, 33 (1938).

[2] *Geogr. J.* 116 (1950) 183–192.

[3] R. B. Dixon, "The problem of the sweet potato in Polynesia," *Amer. Anthrop.* 34 (1932).

[4] R. B. Dixon, "The long voyage of the Polynesians," *Proc. Amer. Phil. Soc.* 34 (1932).

may ask whether there is not also a feasible oversea route from aboriginal south-east Asia to Polynesia, and whether both Asia and America may not independently have colonized the Polynesian islands. We certainly know that more than one race has entered into the forming of the Polynesian stock. Sullivan, Dixon, Handy, and others have recently shown, as had long been suspected by Pacific anthropologists, that the Polynesian tribes are composite and that we must look for more than one geographical source in tracing their complex origins. We must accordingly admit that the discovery in Polynesia of Peruvian culture traits does not prevent other elements from having originated in Indonesia. The converse is also true. The question is however, which route would neolithic voyagers from southern Asia be most likely to follow?

There are three possible routes from eastern Asia to Polynesia although Heine-Geldern seems to be aware only of the two which look most attractive on a political world map (they are in reality the least favourable); the direct route through Austro-Melanesia, and the direct route through Micronesia. The first runs the gauntlet of more than three thousand miles of warlike and alien peoples of negroid race-type who occupied this locality long before the first Polynesians found their way to the east Pacific. The second involves a voyage, against all the prevailing winds and currents, through four thousand miles of Micronesian ocean with only a chance of sighting some tiny and low-lying atoll before reaching the nearest island in the farther four-thousand-mile-wide Polynesian ocean. It was agreed at the recent Seventh Pacific Science Congress (New Zealand 1949), which specially directed anthropological attention to Micronesia, that there was no proof nor even any evidence that Polynesians had traversed this area. Both Austro-Melanesia and Micronesia show the characteristics of buffer-states with only marginal Polynesian infiltration on their windward western extremities which face towards Polynesia itself and the Americas.

But we need not resort to fabulous and artificial stepping stones of neolithic culture to find a way by which Indonesian or south-east Asiatic emigrants could have discovered the lonely Polynesian islands at the opposite extreme of this ocean. There is the third route,[1] longer and more intricate than the two others when studied on a map, but far quicker for pre-European craft, and a natural line of progress in a boundless and uncharted ocean to a destination not already known. For this route is aided by the elements and followed by the ocean itself, sweeping in a broad current that would carry primitive explorers and castaways alike, from the Philippine Sea towards the Aleutian islands and the continental archipelago of north-western America. This New World area derives temperate water and a very mild climate from the outer edge of the Kuro Siwo Current; and from here the vast ocean current turns south-west, directly towards Hawaii in Polynesia. From a geographical and nautical point of view the natural road from south-east Asia to Polynesia goes by way of the north-west American waters, not by way of Micronesia or Austro-Melanesia.

In mileage, measured on a globe, the distance from the Philippines to the nearest part of Polynesia is the same as to the nearest point in north-west America, but in the travelling time for early man the two voyages bear no comparison, even if one adds the extra weeks required to continue southwards to Hawaii. It is of overwhelming importance to distinguish clearly between voyaging distance and voyaging time; the straight line is not the shortest voyage for an aboriginal migrant. Under normal conditions the spread of mankind due east from Indonesia to Polynesia would require many centuries of intermediate settlement, population pressure and repeated pioneering explorations by men and women in open craft against the elements. As opposed to this highly

[1] As suggested by the writer, see *Geogr. J.* 115 (1950) 24, footnote.

artificial and premeditated diffusion, the transfer of craft from the Philippine Sea to north-west America could be all over in a matter of weeks; and from north-west America later explorers, refugees, or even castaways, would benefit from the broad ocean current bearing down into the latitudes of the north-easterly trade-winds, sea and air joining company in a rarely interrupted sweep straight down upon Hawaii. Here they part again, the trade-wind heading for central Polynesia, the ocean current turning for Micronesia and so back to the Philippine Sea.

Captain Voss [1] has provided a practical demonstration of how readily a north-west American canoe can be sailed to Polynesia, and the quantity of north-west American logs that drift ashore in Hawaii emphasizes the point. De Bisschop [2] struggled for years in the Equatorial Counter Current to force a native Asiatic craft due east through Micronesia, hoping to find an Asiatic route to Polynesia. He eventually gave that up without success and setting out from Hawaii instead, in a Polynesian canoe, was able to sail to Futuna, west of Fiji, in thirty-six days, and from Futuna to Java in less than three weeks. We should therefore be more on the watch for Polynesian and even American infiltration into Indonesia, than for infiltration in the opposite direction.

It is noteworthy that nearly all the cultural parallels and analogies which have been commented upon in the technical literature, as existing between early America and the Pacific islands, are focused either around aboriginal Peru in South America or among the north-west American Indians of the Vancouver and Queen Charlotte Islands. These two areas in the Americas have consequently been pointed out by the diffusionists as showing traces of early oversea explorers or drift voyagers from Polynesia. In reality these are the very areas where strong ocean currents set perpetually away from America and towards Polynesia, like giant rivers. Seen from a geographical and maritime point of view the two regions are plainly donors to Polynesia, not recipients.

Many competent observers, and among them Dr. Heine-Geldern, have pointed out far-reaching relationships, partly in race and partly in culture, which seem basically to unite a geographical triangle. One corner marks Indonesia and south-east Asia, the second north-west America, and the third Polynesia. In the order here mentioned each is naturally and readily accessible from the one before, in primitive craft which need spend only a few weeks at sea, drifting or exploring.[3]

[1] J. C. Voss, 'The venturesome voyages of Captain Voss,' London, 1926. Between 1901 and 1904 Voss sailed the *Tilikum*, a converted red cedar wood canoe, from British Columbia to England. The crossing from Vancouver Island to Penrhyn Island took two months.

[2] E. de Bisschop, 'Kaimiloa,' Paris, 1939.

[3] The strongest array of analogies between any two areas is that between north-west America and Polynesia. They include such factors as a remarkable concurrence in blood groups (the Indo-Malay B factor almost totally absent, high O, A present and locally unstable), in body build, skin colour, hair structure, average cephalic index, and a resemblance of physiognomy which is amazing to anyone familiar with both peoples. This is particularly noticeable between the Polynesians and the North Vancouver Island Kwakiutl. It includes furthermore such important comparable elements as the enormous sea-going canoes with bow and stern pieces sewed on, capable of holding upwards of seventy persons with their gear; a neolithic and yet historic elbow-adze almost identical in form in both localities (Olson, 1928); conventional stone and whale-bone clubs remarkably akin in style and workmanship (McLeod 1929, Imbelloni 1930, Skinner 1931); striking analogies in pounders and pestles (Heyerdahl 1941, Ekholm Exhibit 1949); bark-cloth and bark-beaters (Cook 1784, Niblack 1888, Goddard 1924); fish hooks (Gudger 1927); wood-carving and

Reversing this natural motion in his layout of routes across the Pacific, Heine-Geldern defends his view by a survey of the variety of blade forms found in local stone adzes; the quadrangular blade, the " stepped " blade, and the "shouldered" blade, all of which are archaeologically represented both in the Old World and the New, and all of which were also used in Polynesia. He shows the probable evolutionary centre of these various stone blade types to be ancient south-east Asia. In a hypothesis which attempts to bring the blade-types overseas, directly from Asia to Polynesia, he runs however into three obvious difficulties. The first pertains to the island chronology, the second to the existence of corresponding blade types in America also, and the third to the absence of similar blade types and techniques en route, in Micronesia and Austro-Melanesia.

Since it is generally agreed among Polynesian scholars that the neolithic people who brought these blade types to Polynesia arrived in separate waves,[1] roughly over a period from A.D. 500 to A.D. 1300, Heine-Geldern realizes the obvious chronological difficulty in bringing them straight in from the contemporary Iron Age of the Old World. He suggests as an alternative that the Polynesians may themselves have reached the Iron Age stage in Asia but that, after a migration through coral atolls, they would have lost all memory of metal work after " fifty or sixty years." If they were so forgetful, how then we may ask, could they remember in Polynesia what specific stone adze types their long lost ancestors in China had manufactured at a time even before they had used bronze or iron.

To escape from this dilemma, Heine-Geldern suggests yet another explanation; iron was already in general use in Indonesia by the first or second century A.D. where, according to an earlier publication of his, it "spread more rapidly than Hindu culture," [2] and at the time of Polynesian migrations only isolated and backward savages had not acquired its use. It is from these isolated and backward savages that, we are now to infer, trans-Pacific voyagers set out, still with a Stone Age culture, at this late date. But surely only the most advanced of Asiatic nations, with a long maritime history, could carry out such an organized family migration eastwards into the unknown Pacific. Such a people would certainly not carry the rectangular, stepped, or shouldered adze forms of neolithic Asia into Polynesia in the Christian era.

The second reason for doubting that these stone blade types spread due east to Polynesia is that, as Heine-Geldern himself admits, all three blade-forms are also found sporadically from Alaska and British Columbia to South America. If they were developed independently in the Americas then they may also have been developed independently in Polynesia. They would then furnish no argument for racial diffusion. If on the other hand they were brought to the Americas by immigrants from east Asia along the early neolithic Aleutian route, then they may subsequently have been carried on from the Americas to Polynesia.

The third defect in Heine-Geldern's argument from blade types is best illustrated by quoting his own works on the subject. If the manufacture of stone adzes was diffused thousands of miles eastwards from neolithic Asia to Polynesia, then it must either have spread through the coral atolls of Micronesia

art-styles (Schurtz 1895, Barbeau 1929); customs and social systems (Jacobsan 1891); and even language (Campbell 1898, Hill-Tout 1898). Finally the mutual ignorance of such basic and almost universal culture traits as pottery and loom-weaving.

[1] The present writer proposes that the first was from Peru with a subsequent arrival from Asia by way of north-west America.

[2] R. Heine-Geldern, "Prehistoric research in the Netherlands Indies," in 'Science and scientists in the Netherlands Indies,' New York, 1945, p. 148

or else through Melanesia. But Heine-Geldern pointed out in 1932 [1] that Melanesia cannot have served as the required stepping-stone because of "the radical difference in Polynesian and Melanesian blade forms." Turning next to Micronesia he found another barrier. The geology of the Micronesian atolls had caused the manufacture of stone tools to be abandoned locally for implements of shell and coral. As he himself pointed out, the very few stone blades found in Micronesia are limited to the rare volcanic islands and, even there, show no homogeneity in form. He says: ". . . in general the stone blade had in Micronesia been almost completely replaced by the shell blade which, as long as its forms and dependency of material are not systematically examined, can hardly be compared with the prehistoric stone blades of Indonesia." Thus there is no eastward path for his stone blade forms from Indonesia to Polynesia. How then, can he now say of Polynesian adze blades: "Even the way they spread from the Asiatic continent, and while spreading developed, can be traced to some extent." And he now admits that, apart from the sporadic finding of adze blades in the Andean region which "may very well be considered as traces of Polynesian influence," there is another centre of Polynesian-like blades in north-west America. About this adze form he says: ". . . whether this may be derived from east Polynesia or, as seems more likely, directly from East Asiatic types, need not concern us." In view of the natural ocean drift, it ought to concern us. And so with the Andean specimens; in both these American areas stone blades were still used by able and intelligent boat-builders when Polynesia received its immigrants; in Asia they were not.[2]

Physical anthropologists working in Polynesia have abandoned the old hypothesis that the Polynesian type is closely related to the Malay. The pioneer work of Sullivan, Dixon, Shapiro and others has revealed that the Polynesians differ profoundly from the Malays in stature, skin colour, hair form, nose form, cranial shape, and blood types. Apparently discounting, like most modern anthropologists, the possibility that the Polynesians are of Malay origin, Heine-Geldern loosely states that some European-like types reported from the interior of southern China and central Celebes may be the vestiges of proto-Polynesians. He forgets that in so doing he abandons the only sound argument for a Polynesian arrival from Indonesia; namely that certain elements found in the Polynesian language are distantly related to Malay.

The discovery of the racial difference between the Malays and Polynesians only serves to illustrate the principle that linguistic elements belong not to the race but to the community. In my view, some language elements may have spread with migrants from south-east Asia to north-west America, and so into the eastern Pacific. A basic unity of north-west American and Oceanic languages has been strongly propounded by Campbell[3] and Hill-Tout.[4] The physical

[1] R. Heine-Geldern, "Urheimat und früheste Wanderungen der Austronesier," *Anthropos*, 27 (1932) 584. (The original in German.)

[2] Analogies between the north-west American and Polynesian adze types had been pointed out by Captain Cook (1784), Dixon (1789), Jacobsen (1891), Holmes (1919), Olson (1929), and recently by the Ekholm exhibit for the International Congress of Americanists in New York (1949). The analogy is not restricted to mere archaeological blade-form, but includes choice of material, method of securing the blade and the use of the forked "elbow" handle.

[3] J. Campbell, "The origin of the Haidahs of the Queen Charlotte Islands," *Trans. Roy. Soc. Canada*, 2nd Ser, 3 (1897–98).

[4] C. Hill-Tout, "Oceanic origin of the Kwakiutl-Nootka and Salish stocks of British Columbia," *Proc. and Trans. Roy. Soc. Canada*, 4 (1898). Hill-Tout accumulated enough linguistic data to feel convinced that the north-west Indians were of direct Polynesian descent.

features and somatology of some north-west American island tribes agree to a remarkable extent with those of some Polynesian sub-tribes, particularly with the Maori who are the purest representatives of the last migration to Polynesia.

Heine-Geldern calls attention to the scarcity of Quechua-Peruvian words in Polynesian dialects. He overlooks the rather important fact that Quechua was introduced as a leading language in Peru only by the Incas, that is a few centuries before the Spanish Conquest and several centuries after the establishment of the first colonies in Polynesia. All we know about the extinct pre-Inca languages spoken by the Tiahuanaco, Early Chimu and Early Nazca is that Quechua was certainly not one of them and could not therefore have been carried to Polynesia in the early period of Polynesian migrations.

While bringing the adze to Polynesia from China and the Philippines, Heine-Geldern relates the unroofed religious stone-structures of Polynesia with those of Assam and Java. He refers to the fact that Hutton has commented on the close parallelism between certain megalithic structures of the Nagas and those of eastern Polynesia, but forgets to add that Hutton extended his comparison still further and included the pre-Inca buildings of Tiahuanaco and early Peru.[1] Since these structures are found most conspicuously on the eastern fringe of Polynesia, far beyond the feasible range of Assam or Java but just where the ocean escalator rolls in from the pre-Inca culture area, geographical logic as well as the culture pattern points to the route from South America to Polynesia as the only feasible one.[2]

It is strange that Heine-Geldern should regard the views of the late James Hornell concerning the American-Polynesian spread of the sweet-potato, as "once for all" disposed of by the successful outcome of the *Kon-Tiki* expedition. He has not apparently read Hornell's two papers on this subject very carefully. For it was Hornell who, after a similar article in 1945, published in 1946[3] an excellent paper with the sole intention of showing that (water-proofed) Peruvian balsa rafts with Peruvian crews, not Polynesian visitors, are likely to have brought the sweet-potato to Polynesia. Surely Hornell's opinion in this matter is not "disposed of," but very strongly supported, by the result of our expedition.

The venesection-bow has not been found among peoples in Asia or Indonesia, but has been found on the Polynesian side of Papua-Melanesia and in South America. Since its geographical distribution serves so well as an argument for a diffusion to South America of Oceanic culture traits (upstream) through Polynesia, it is even more significant if we reverse the direction of the transfer.[4] I must confess that the existence of the bamboo nose flute, the sling and the Pleiade year, in Indonesia as well as in South America and Polynesia, decreases their value as indicators of a specific east-to-west transfer. But has it occurred to Heine-Geldern that all the various elements hitherto listed by

[1] J. H. Hutton, "The use of stone in the Naga Hills," *Jour. Roy. Anthrop. Inst.* 56 (1926) 75.

[2] The pre-Inca graves contemporary with Tiahuanaco contain no bronze, iron, or other hard metals, whereas Heine-Geldern himself once wrote (1945, p. 150) of the megalithic graves in Indonesia he now seems to propose as proto-Polynesian: "... all the stone cist graves and slab built graves of South Sumatra, central and East Java contained glass beads and metal, bronze, gold, copper or iron. The same was the case in similar graves that have been investigated in the Malay peninsula."

[3] J. Hornell (1946), *loc. cit.*

[4] Besides Nordenskiöld (1931), who simply referred to the venesection-bow as an Oceanic culture element in South America, G. Müller (1936) and the Vienna Medico-historical Exhibition have stressed the identity between the Oceanic form and that of continental South America. Steward (1949) also points out this parallel.

him as indicative of a west-to-east transfer to Polynesia, exist also in one or both of the American territories above specified? There is nothing Indonesian in Polynesian race or culture that is not also shared by the American Indians to the windward, or else available through the intimate neighbourly trade with the nearest marginal islands to the west, in Melanesia.

Heine-Geldern ends his paper by advancing the theory that Easter Island was discovered and settled from South America, not by native South Americans however, but by people who had formerly come to South America from Indonesia by way of Polynesia. It is my merit, he says, to have shown that such voyages were completely feasible. I cannot accept this generous tribute, nor would I bestow it upon anyone else who has faced the living sea rather than the map in plotting diffusion routes across an ocean.

History has shown that, even among advanced civilizations, the first discoveries of land concealed beyond endless ocean horizons are the result of drifts; or of expeditions into the unknown ocean wastes that were aided by steadily favourable winds. Our own western civilization, not to mention the Romans and the Arabs, had discovered Indonesia centuries before Columbus made his ocean voyage with the trade-wind to America. Yet it was not from Indonesia that these great civilizations were to reach Polynesia or even Micronesia. As soon as the Americas had been reached and modern man with his sailing-ships had gained a foothold on the American side of the Pacific, that entire ocean was swiftly crossed. Micronesia itself was first discovered by Magellan, who crossed from the southern end of South America, and Melanesia and Polynesia were discovered by Mendaña who set out from Callao in Peru just as our expedition did in 1947. An entirely oceanic territory can only be discovered along the natural ocean roads. Once the discovery is made and the road back known, only then will good sailing craft, even beating against the wind, take the skilled voyager back and forth between points known to him. Such was later the case in Polynesia.

It can never be sufficiently stressed that primitive oceanic migrations cannot be judged in miles or inches, but only in centuries and days. A voyage anywhere across the Pacific will not differ in measured distance if we reverse its direction. But distance is an entirely illusive matter in primitive craft at sea. Time is the only voyaging measure that matters and the only one that was known to aboriginal migrants. The length of a sea journey is set not primarily by the route but by its direction.

A correction to the map accompanying Professor Heine-Geldern's paper

The text figure at page 185 of the last issue of the *Journal* was added to Professor Heine-Geldern's paper in an attempt to explain the location of the sites referred to by him and was not seen by him before publication. In its title, "palaeolithic" should read "neolithic" and was meant to indicate sites at which the use of stone tools had persisted. The site at Kaloempang is in Central Celebes and not on the coast.—*Editor.*

SAND FORMATIONS IN SOUTHERN ARABIA

BRIGADIER R. A. BAGNOLD, F.R.S.

THE NEED for some knowledge of desert dunes and their growth and movement is increasing as roads, landing grounds, oil installations and pipelines spread into the sandy regions of the world. And, apart from this utilitarian aspect, the existence of vast and strikingly organized sand shapes, uniform in type over large areas but changing suddenly in type as one passes from one area of the region to another, presents us with some stimulating scientific problems. Why and how have these distinct sand shapes appeared, how long have they been in existence and what is the present trend of their development?

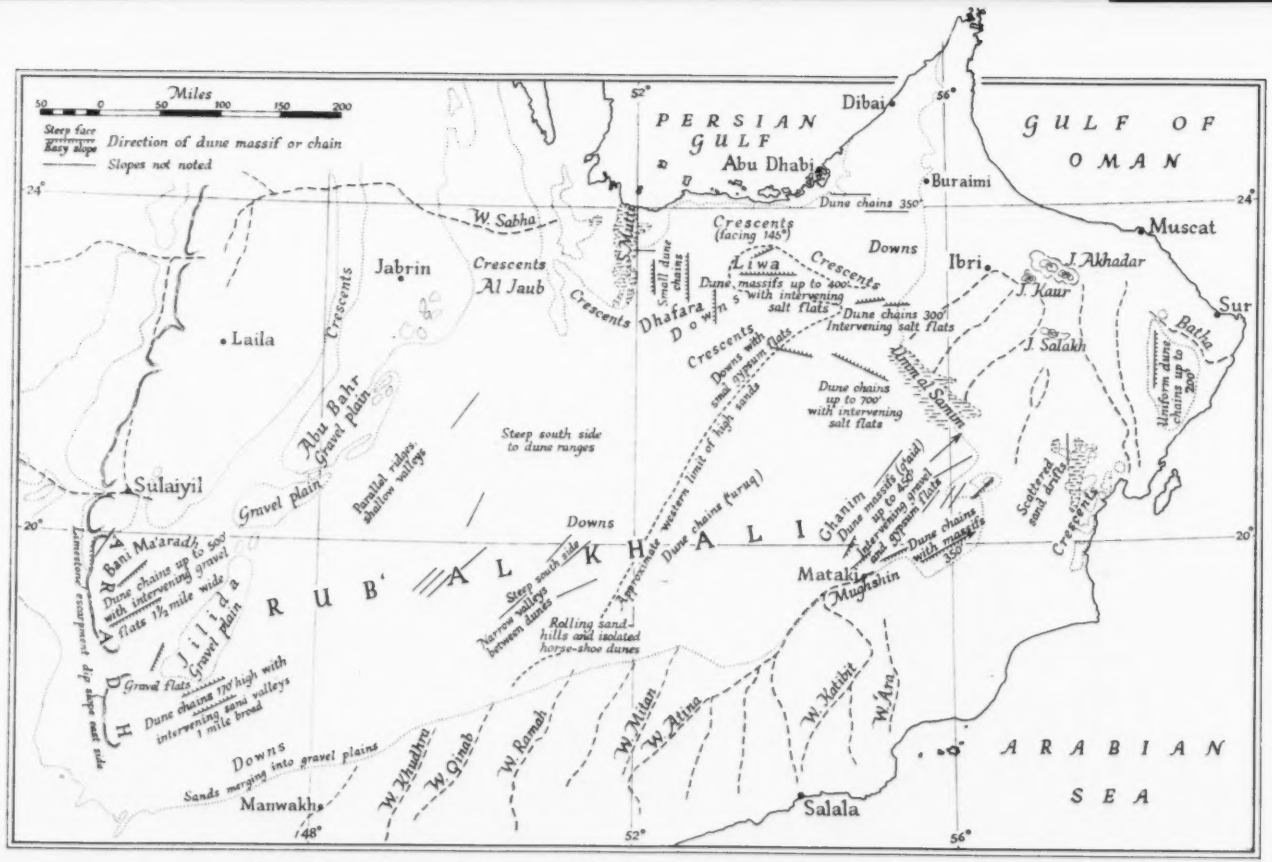
There is abundant evidence that the surface relief of the floor on which the dunes lie has no direct effect at all on the shapes which the dunes assume in any area. It seems fairly clear that the existence of a dune system of a given type depends mainly on some characteristic of the local wind regime; the wind's strength and direction and the variation of both during the year. On what particular characteristic of the local wind regime a dune type depends we do not definitely know, except in the simple case of the isolated crescent, horseshoe or *barchan* dune. The "population curve" of the size-grading of the sand material available for dune building also has an effect which I will touch upon later.

Since the dune shapes cannot be reproduced in miniature in a laboratory wind tunnel, we can only find out more about them by comparing known dune types with known local wind regimes as obtained from wind records. But this is unfortunately very difficult at present. Continuous and reliable wind records are seldom taken over periods of years in the interiors of deserts (and when they are, the published summaries never give us enough information to work on) and few travellers have thought to define or to distinguish the dune shapes they have seen.

We are therefore very much indebted to Mr. Thesiger for the information he has collected on his recent journeys in Arabia and for the first dune map of the great southern sands. As will be seen from the map, he distinguishes four types of sand formation—dune chains, downs, crescents and sand massifs. Having had the pleasure of questioning him at length about these types, over his many excellent photographs, it may not be out of place for me to add the following notes in amplification of the map.

Some remarks must first be made on the winds in the interior of Arabia. It is known that the dominant wind over the Bahrain–Qatar area of the Persian Gulf is the summer *shamal* which blows strongly from the north-north-west. But coastal winds cannot be assumed to extend into the interior. Owing to the complete absence in the past of records from the interior of the peninsula, the general trend of its land winds has been deduced by meteorologists from barometric data for the surrounding regions. Thus Brunt [1] shows the winter wind as tending to blow from the north-east and the summer wind from the north-

[1] 'Weather study,' 1942, pp. 53 and 57. Sir David Brunt tells me that as far as Arabia is concerned the winds over the peninsula shown in his earlier 'Physical and dynamical meteorology' may be considered as superseded.



Dunes in southern Arabia, from Mr. Thesiger's observations and other sources

west. He also confines the south-west monsoon to the Indian Ocean and denies it access to the Arabian desert, except possibly in the extreme south-east.

These very general deductions take no account of possible disturbances due to large differences of ground temperature within the Arabian peninsula. In spring the air above the sands is likely to get much hotter than the air above rocky ground which has not had time to heat up to the same extent after the cool of winter. This should create local depressions over the sands and cause local ground winds to blow inwards across the sand boundary. To a lesser extent the reverse action should take place in the late autumn. These thermal winds should be more pronounced in the northern parts of the peninsula where the seasonal temperature changes are greater.

Arab experience, as I am informed by both Philby and Thesiger, is that the wind in Arabia blows both from the northerly and from the southerly quadrants, winds from the easterly and westerly quadrants being rare. Thesiger also tells me that tales of severe sandstorms, such as are common in Libya, are not heard in the Rub' al Khali, and he gathered that the region is a relatively calm one.

The sand-driving effect of the wind

In assessing from wind records the direction and intensity of sand-driving, one must remember that the sand-driving effect of the wind, as manifested in the type and orientation of the dunes, is a cubic function of the wind strength. It is not therefore sufficient to know the relative numbers of occasions on which the wind blows from each point of the compass. A few storms during the year may entirely dominate the wind regime as it affects the dunes. Instead, if continuous wind records are available, we must take each compass direction in turn and add up separately the numbers of occasions on which winds of each category on the Beaufort scale above Force 3 have been recorded. We have then to multiply each total by the appropriate sand-driving factor for that particular Beaufort strength (the factor, being based on the cube of the wind speed, increasing very rapidly as we ascend the scale).

For sand of average grain size and composition, on an open sand surface entirely free from vegetation, the volume of sand in cubic metres per annum (S) which will be driven past a fixed transverse line 1 metre long, in any compass direction, should be given approximately by the formula:

$$S = 3{\cdot}25 \times 10^{-3} \frac{N}{P} \left(\frac{v - V_t}{\log_{10} z/k'} \right)^3$$

Here N is the number of occasions on which the wind is recorded as blowing in that direction with speed v, in miles per hour; P is the number of regular observing times per day (assuming no night recording); z is the height of measurement above the open ground; k' in the same units is the equivalent of 1 cm. (at which height above the sand, owing to the peculiar mechanism of sand-driving, the wind speed is always constant at 10 m.p.h. no matter how strong the wind above); V_t is this constant speed of 10 m.p.h. It has been assumed in the above formula that the wind dies down at night, but some allowance has been made for a reasonable extension beyond the usual 12-hour recording period. In default of night records we have to guess. The height z is usually not above open obstructionless sand, because the station is probably at a landing ground near an oasis with buildings, palms, etc., which obstruct the wind. Here too an allowance has to be made and I have assumed that z should be taken as half the recorded height of measurement.

For an actual height of measurement of 12 metres, the factors by which N should be multiplied in order to give us S are as follows:

Beaufort strength	4	5	6	7	8	9
Mean wind speed (m.p.h.)	15	21	28	35	42	50
Factor	0·018	0·2	0·86	2·3	4·8	9·4

If the sand is even slightly vegetated this factor must be reduced considerably, but to what extent it is difficult to estimate.

The resulting values for each Beaufort number can now be added together, and the sum gives the volume of sand in cubic metres which would be driven over the ground during the year by the wind component dealt with. If the process is repeated for each direction we can draw a "sand movement rose" corresponding to the original wind rose.

In March 1941 R.A.F. meteorological stations were established at Hail and Riyadh, and their thrice daily records are available in England. The records cover three and four complete years respectively and appear to be the only continuous wind records for any place in the interior of Arabia. Through the courtesy of the Director of the Meteorological Office, Air Ministry, I have been allowed to borrow these manuscript records and from them I have computed the sand-driving power of the wind at the two places. The results are given in the following table.

Sand-driving effect (cubic metres per annum)

	Hail	*Riyadh*
N.	0·12	0·28
N.N.E.	1·1	0·08
N.E.	0·11	0·21
E.N.E.	0·51	—
E.	—	—
E.S.E.	—	—
S.E.	0·26	0·09
S.S.E.	—	—
S.	—	0·10
S.S.W.	5·8	—
S.W.	5·9	—
W.S.W.	1·1	—
W.	0·64	—
W.N.W.	0·25	—
N.W.	0·21	0·28
N.N.W.	0·69	—
Arithmetic total	16·7	1·04

	Hail	*Riyadh*
Total number of observations per year	2095	2095
Number of occasions per year when wind exceeded Force 3	72	67
Number of occasions per year when wind exceeded Force 6	6·6	nil
(80 per cent. of the storms at Hail occur in March, April and May)		

Riyadh lies on the north-west corner of Thesiger's map and its winds are therefore of direct interest to us. Hail lies some 300 miles to the north-west of

Riyadh and immediately to the south of the Nafud sands. It is far enough north to be affected both by the Mediterranean depressions which pass eastwards across the head of the Persian Gulf, and by the northerly winds which blow over Iraq.

It will be seen that, owing to the occurrence of a few storms each year, the potential sand movement is sixteen times as great at Hail as at Riyadh and also that the dominant directions are nearly opposite. The dominant northerly wind direction at Riyadh conforms well with Brunt's deductions, the presence of an appreciable southerly wind accords with general Arab information and the lack of storms accords with Thesiger's conclusions.

Types of dunes

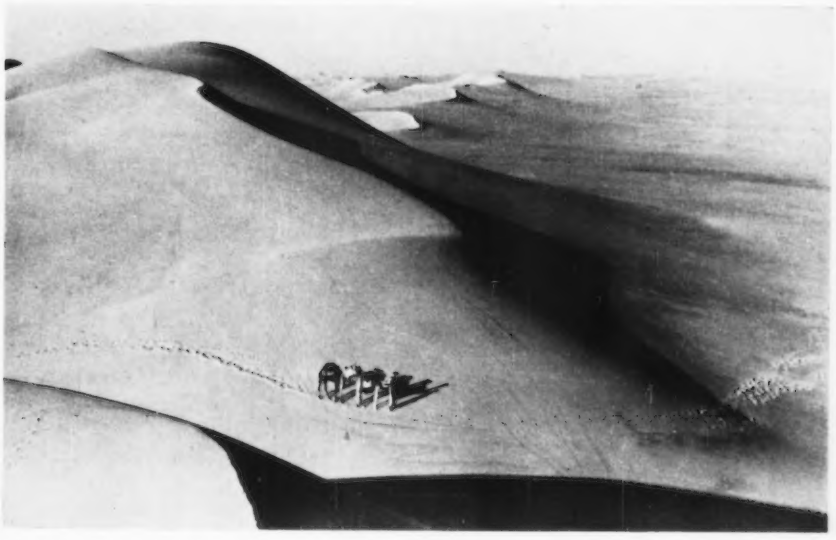
We are now in a better position to discuss the forms and orientations of the Rub' al Khali dune systems. The broad impression I have gained from Thesiger's descriptions to me is that, although the majority of the sand formations are of common recognizable types, there is a confusion or complication about them that is unusual. The cause probably lies in the unusual distribution of the winds which according to local experience blow fitfully from generally opposing directions; whereas in Libya, for example, nearly all winds possess some northerly component.

Dune chains (or longitudinal dunes).[1]—Essentially, a dune chain consists of a single straight row of sand summits, connected by a continuous wavy crest. As the chain grows bigger and older however, its base or plinth tends to widen to perhaps two miles in width, and to become a high, continuous, straight sand ridge along the back of which a number of dune chains may ride side by side. In places the dune chains may be absent, and the broad back of the ridge then resembles undulating downs.[2] The main sand ridge may extend unbroken for a hundred miles or more. Dune chains are most probably orientated in the direction of the dominant sand stream. On the other hand, it is possible that they may be aligned in the direction of the resultant, or vector sum, of the sand movements due to all the various winds during the year. No on-the-spot wind records are anywhere available to enable us to decide this point. It is important because there is much evidence which points to the necessity for a considerable sand-driving component across the main alignment of the chain to produce this commonest type of dune. Owing to the action of this cross-wind the cross-section of the dune chain is usually unsymmetrical, with a gentle upward slope on the windward side of the cross-component and a steep lee face, much of which lies at the limiting angle of slip. Hence the significance of the side-hatches against the map lines indicating the dune chains. They mark the side from which the principal cross-wind blows.

The Libyan name *saif*, meaning a sword, suggests that a dune chain has a hilt and a point, and this is generally the case. The advancing down-stream end dwindles to an unmistakable point whereas the up-stream end is large, blunt and rather shapeless. This "sense" of the dune chain is important because it indicates which way the sand is moving. Thesiger has shown the sense by arrows wherever he was certain about it but in some places, notably in the south-west, it was not clearly apparent.

[1] The local name is *urq* (pl. *'uruq*); in Libya they are called *saif* (pl. *siyuf*). The type is illustrated in Plate 1 and in Thesiger's earlier papers, *Geogr. J.* 111 (1948) 6 and 115 (1949) 22.

[2] See in particular the photograph facing *Geogr. J.* 111 (1948) 6, which shows the down-like summit of one of the highest of these dunes.



1. Dune chains ('uruq) 400 to 500 feet high, Bani Ma'aradh, western sands

2. Downs in Dhafara

Photo. W. Thesiger

3. Crescent dunes (rabadh) east of Liwa

Photos. W. Thesiger

4. Isolated dune-massifs (qa'id) 400 feet high, Ghanim in the south-eastern sands

In the centre and south-west of the Rub' al Khali the map shows dune chains running roughly north-east and south-west. In default of any definite evidence to the contrary we must assume with Brunt that the "sense" is from north-east. (Winds due to local disturbances would seem unlikely to preserve a common direction over so vast an area.) On the other hand Thesiger is very definite that the south-western extremities of the chains south of Sulayil are broad and rounded, as one would expect the up-wind ends to be. Moreover, in no case do any of these dunes extend right to the brink of the big escarpment; they all end just short of it on an open gravel plain. It seems quite likely that the general south-westerly advance of the dunes is checked by strong thermal winds which blow into the sand zone across its boundary. The escarpment is so high and sheer that it does not seem possible for appreciable quantities of sand to be lifted up over it from the south-west. With regard to the sense of the cross-wind in this area, Thesiger's hatches and notes ("steep south sides" in two places in the centre of the map) would agree with Brunt's north-westerly wind. But unfortunately the group of big dunes south of Sulayil contradicts this inexplicably.

The wind pattern on the south-east and east sides of Oman is known to be very confused. Thesiger's map shows unequivocably that the dominant direction of sand driving is from the south-west and south, and that the cross-wind blows from the south-east and east respectively. We are here so close to the ocean that the influence of the south-west monsoon cannot be neglected.

The dune chains in the north-east (inland of Trucial Oman) offer an interesting example of duality of direction, some running north and south while others, quite nearby, run east and west. This duality of direction is also found in the Libyan desert, though the sudden change of direction there is much less. On the theory that cross-winds are necessary for the development of dune chains, and that the alignment of a chain is that of the single dominant wind rather than that of the resultant of all winds, this duality is not difficult to explain. It is clear from the hatches that we have here two winds, one from due north (the known *shamal* that blows down the Persian Gulf in summer) and one from due west (probably a local storm direction). Suppose that the sand-driving powers of the two winds are very nearly equal—so nearly equal that the relative dominance becomes reversed half way across the area. Then what was the cross-wind in one place becomes the dominant wind in the other, and the dune alignments will be at right angles to one another.

Downs.[1]—Thesiger describes these as undulating sands on the tops of widely spaced dune chains. This description also fits the downs which cover a large area in the Egyptian Sand Sea. I found that the grain size distribution of the sand of the Egyptian downs differed radically from that of the dunes. Whereas the dune sand is very uniform in size (population curve very steep), the sand of the downs contains nearly equal proportions of sand of all sizes (population curve flat-topped over most of the range). Experience the world over shows that dune chains are composed of sand of a very narrow range of size, that of quarter of a millimetre predominating. If therefore we suppose that in some areas the original source of the sand supply had an excess of both fine and coarse grains (over and above the small proportion needed for dune-building), this excess must go somewhere and, as it is rejected for dune-building, it seems reasonable to assume that it accumulates along the footing of the dune to form a plinth. It would be interesting to know whether the downs of the

[1] See Plate 2.

Rub' al Khali have the same composition characteristic as those of the Egyptian Sand Sea. I will refer later to the curious hollows (*huqun*) in these downs.

Crescents.[1]—The essential feature which distinguishes crescent dunes is the isolated symmetrical crescentic shape of the slip-face, whether viewed in elevation or in plan. By slip-face is meant the limiting 33° slope on the lee side, down which little avalanches slip whenever the wind drives sand over its brink. The commonest form of crescent dune is the isolated barchan. This can be described very simply as a flattish circular or elliptical dome of sand, anything from ten feet to a quarter of a mile across, out of which a large concave bite has been taken from the lee side. The resulting crescent slip-face must therefore be highest in the middle, and must dwindle to nearly nothing at its two extremities or horns.

There is much evidence that the isolated barchan form of the transverse crescent dune results from a wind regime which blows overwhelmingly from one narrow fan of directions. The tangent to the centre of the crescent slip-face lies at right angles to this direction, as does the line joining the horns. The dune advances with its two horns outstretched down-wind or down the sand stream. When, as is often the case, the dune field is strung out into a long narrow belt the direction of the belt is also down-wind.

Transverse crescents, though in all cases requiring a nearly uni-directional wind, do not always occur as isolated barchans. If, for instance, the intensity of the sand stream decreases as one goes down the belt, the rate of advance of the crescents becomes slower in front, and they tend to run one into the next. Again, the crescent form would begin to appear in the sides of dune chains when, over a period of years, one of the two winds necessary for the chain formation failed to blow; or became overwhelmed by an increase in the strength of the other; or was cancelled out by a new wind from the opposite direction. In any of these cases, the original dune chain formation would ultimately disappear altogether if the new conditions persisted for long enough. That some such change in the wind regime has occurred in the area south of the Trucial Coast seems the likeliest explanation, both of the presence of crescents among the dune chains and of the pattern of the crescents themselves. Photographs show that small but unmistakable crescent slip-faces have formed on the south sides of low dune chains and that they face south-south-east. The two horns of such crescents are however curiously extended and reach out, long, thin and parallel to one another, towards the next dune chain. The whole sand pattern is therefore that of a criss-cross mesh. It will be noticed that the east and west dune chains and massifs are here very large and many centuries of changed winds would be needed to alter their forms appreciably; but the north and south dune chains are shown as small and are therefore probably much younger. It may well be that the northerly shamal now penetrates further inland than it used to do.

We have no information as to what the crescents are like in the long belt east and south of Riyadh. Reference to the table already given shows that the dominant sand wind blows from a narrow northerly fan of directions, the mean being about north-north-east, and that the two other winds, from the north-west and south-south-east, very nearly cancel each other out. Hence we should, without having seen the map, predict that if any dunes existed in this area they would be of the crescent type, and that their direction would be from the north-north-east. The map confirms this prediction remarkably well, in spite of the fact that the dune belt actually lies a considerable distance from Riyadh.

[1] See Plate 3 and also *Geogr. J.* 107 (1936) 36.

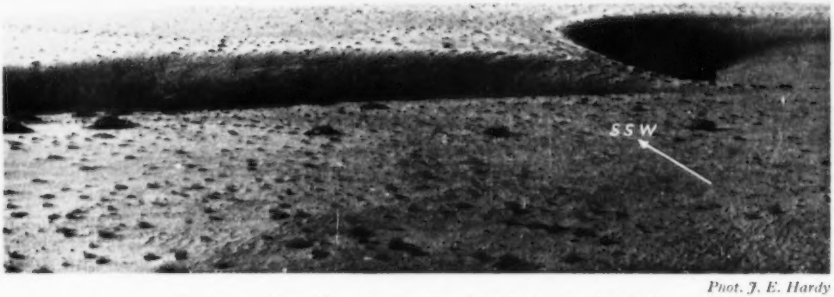
5. Dune massifs (400 feet high), southern Liwa

Photos. W. Thesiger

6. Dune massifs and salt flat, southern Liwa

Phot. W. Thesiger

7. A sand-hollow (huquna) north of Liwa, 100 feet deep and with rock floor exposed



Phot. J. E. Hardy

8. Deep horseshoe depression (falj) in the Nafud

Dune massifs.[1]—These seem to be something akin to dune chains, but they are, I am told, quite unmistakable forms. They differ from dune chains in that the summits rise far higher above the general crest level of the chain, in the form of irregularly shaped conical hills whose steep sides are dimpled with small hollows and terraces.[2]

Isolated hollows in the sands.[3]—According to Thesiger these resemble gigantic foot-marks or hoof-marks, 100 or more feet deep at the heel, where the desert floor is often exposed and free of sand. At the back of the heel-mark the sand rises steeply as a crescent slip-face, immediately behind which is a broad sand dome rising well above the level of the downs and visible from afar. Towards the toe the bottom rises gently to the level of the downs. The breadth of the whole hollow may be 300 to 400 yards across the top.

This description tallies exactly with that of the *falj* (pl. *faluj*) given me by Dr. J. E. Hardy who crossed the Nafud some years ago on anti-locust work. The faluj have been generally thought to be unique to the Nafud and it is therefore of interest to find that they also exist in another far distant part of Arabia. Unfortunately Thesiger has no clear photograph of one of these hollows, but I have one taken by Dr. Hardy which leaves little room for doubt that a falj is but a full grown barchan dune almost submerged by the growth of downs everywhere around it except in the protected lee of its crescent slip-face.

We do not know the resultant sand-driving wind direction in the neighbourhood of the huqun of the Rub' al Khali, but Dr. Hardy tells me that in the Nafud the "foot" points somewhere between north and north-east (in those in the downs south of the Trucial Coast the "foot" points south). The direction in the Nafud agrees very well indeed with the almost uni-directional south-south-west sand-driving wind as recorded at Hail, and this is strong evidence in favour of the barchan explanation of the hollows. It seems therefore that these great crescent hollows are the last remnants of exposed desert floor in areas where all else has been submerged under a depth of a hundred feet or more of sand downs.

This idea avoids the extremely difficult, if not impossible, task of finding a physical explanation of how any kind of natural wind action can lift sand out from the bottom of a deep hollow against gravity at a greater rate than it would blow sand into the hollow aided by gravity. In both areas perennial vegetation is reported on the lower half of the crescent slip-faces and we may conclude that the rate of advance of the face into the hollow is very slow indeed. It could hardly be more than a few inches a year and, assuming the hollows to be a thousand yards long, they are likely to last several thousands of years yet before they become filled in.

APPENDIX

Note on folding map

The map published with this *Journal*, which illustrates Mr. Thesiger's paper in the last issue, has been drawn from his compass traverses made in November and December 1948, between January and April 1949 and between January and March 1950. It incorporates the results of his journeys between Mataki and Bai in 1946–47 and between Sabkhat Mutti and Sharja in 1947–48. The inset map relates to the earlier part of the 1947–48 journey.

[1] The local name is *qa'id*. See Plates 4, 5 and 6 and also *Geogr. J.* 108 (1946) 135; 111 (1948) 11; 113 (1949) 36; and 116 (1950) 141 (both photographs).

[2] For very similar dune massifs (*ghourd* (*pl. oghroud*) and *demkha*) in the French Sahara see Capot-Rey, *Trav. Inst. Recherches Sahariennes* 5 (1948) Plate II, photos. 1 and 3.

[3] The local name is *huquna* (pl. *huqun*). See Plates 7 and 8.

The plots of Mr. Thesiger's traverse have been adjusted to his observed latitudes and to the most recent positions for Muwaiqih, Ibri, Haij, Jibail Fahud, Jabal Salakh, J. Kaur and J. al Akhadar. Certain details from the "Bandar Abbas" and "Muscat-Masira" sheets of the 1/M map have been incorporated. In the light of the now accepted position for Jabal Kaur and Mr. Thesiger's later positions for Bir Balagh and Tinha Turban, his route from Mataki to Bai has been replotted with an amended rate of travel.

The heights are from aneroid readings corrected to mean sea-level at Bahrain and Masira Island; the Society is indebted to the Director of the Meteorological Office for supplying the corresponding readings at these two stations.

G. S. HOLLAND

Biological and geological collections

Mr. Thesiger has deposited at the British Museum (Natural History) a large collection of plants from the Rub' al Khali, the Hadhramaut, Dhufar, Oman and the Hahaz mountains. The collection has been named at the Museum by Mr. A. H. G. Alston, Dr. W. R. Philipson and Miss Hillcoat who have also supplied the botanical names used in Mr. Thesiger's papers in the *Geographical Journal*, the identifications being in most cases from his specimens. Mr. Thesiger has also deposited in the Museum a list of plant names in Arabic. Acknowledgement is due to Mr. T. C. S. Morrison-Scott for the identification of a number of mammals.

A collection of rocks and minerals has been deposited in the Museum and these have been identified by Dr. C. W. Campbell Smith and Mr. P. M. Game. Rocks from the following localities in Oman, collected in 1950, have been identified by the geologists of the Iraq Petroleum Company. The collection is in the company's possession.

Hamra Duru'.—Found *in situ* at Falaj in the wadi Zibra: (1) Translucent microgranular chert without inclusions, shattered and cemented by calcite. (2) Pink radiolarian chert with much unresolved dirt in the matrix and very numerous radiolaria and spicules, all of pure recrystallized silica. (3) White chert replacing an oolitic limestone. (4) Slightly ferruginous microolite with some very angular clear quartz sand-grains.

Wadi Aswad.—Pebbles from the bed of the wadi, under Gharif Aswad: (1) White radiolarian chert with numerous radiolaria and fine spicules; abundant submicroscopic dust inclusions. (2) Red and white banded chert full of fine replaced detrital grains; few radiolaria. (3) Black and white chert with numerous minute crystals of ? haematite and ? dolomite. (4) Dark, very altered doleritic rock, very fine grained; much calcite and altered felspar.

Gharif Aswad.—Found *in situ* at the southern end of the escarpment, recrystallized limestone with rare silica grains and containing the following upper Paleocene shallow-water fauna: *Lockhartia* cf. *haimei* (Davies); *Lockhartia* cf. *tipperi* (Davies); *Lockhartia diversa* M.S.; *Alveolina* cf. *primaeva* (Reichel); *Dictyokathina simplex* M.S.; *Kathina* sp. (genus M.S.); *Quinqueloculina* sp.; *Valvulina* sp.; *Dasyclad alga*; *Peneroplis* sp.; *Cibicides* sp.; *Anomalina* U. Coll. sp. 2; *Cytherura* sp.

Hammat Rafash.—Pebbles from shingle beds: (1) White and yellow radiolarian chert with numerous tiny inclusions of ? calcite, ? dolomite, and ? siderite; silica crystallized. (2) Chert replacing a finely detrital rock; silica crystallized. (3) Red and yellow radiolarian chert with minor inclusions of detritus; silica crystallized. (4) Hard sandstone with ferruginous cement; grains angular, no regrowth of quartz. (5) White chert with conchoidal fracture; scattered inclusions of very fine calcareous detritus; rare radiolaria. (6) White chert with few inclusions, shattered and recemented by calcite.

TRAVELS IN HIGH ASIA AND THE ARCTIC

THIS MY VOYAGE. By TOM LONGSTAFF. *London: John Murray*, 1950. 9×5½ *inches; 324 pages; maps and illustrations.* 21*s*

THE APPEARANCE of Dr. Longstaff's book is an event in the literature of travel. The bulk of what he records in 'This my voyage' is to be found by searching the *Journal* and other publications through the first half of the twentieth century. If he had dished up a mere *réchauffé* of these old papers into one volume, it would still have been a valuable book. But Dr. Longstaff has been content with nothing of the kind. Without the loss of any of the zest and fire which carried him through the journeys themselves, he has succeeded in weaving them into a retrospective whole, arranging his material regionally, disregarding very largely the sequence of time and presenting to us each of his regions in turn, with its human life and natural history.

He tells us that he tried to keep himself out of the picture, but admits his failure to do so. The reader will surely rejoice that he "failed." For the impressions here collected into a single design are those of a highly individual artist, with a remarkable eye matched only by his gift for interpreting all he sees.

We find him first learning, in the Alps, the grammar and syntax of this business of travel, though it is of course only in retrospect that this young climber is seen as the traveller "qualifying himself"; and possibly for that reason this chapter seems nearer to being unsuccessful than any except the one on Everest.

The interest quickens with the first experience farther afield. "Now for the frosty Caucasus"—and we are off. At once we see the traveller emerging from the climber; with a strong sense of the history of man, bird and beast, the sense which later was to turn him instinctively to High Asia and Arctic rather than to Rockies and Antarctic. Thus the Caucasus, presented to us so happily, does not end with the ice and rock of Shkara, absorbing enough though that story is; there are also the people of Georgia and the valleys and life of Svanetia and much else.

The scene shifts to the Central Himalaya. At once we see a good example of this generous traveller's recognition of those who went before, when he meets the aged Kishen Singh, the secret surveyor "A.K." of the 1870's. We go on into Kumaon and to the romantic climb with the Brocherels to the rim of the Nanda Devi sanctuary, reached at the point whose later designation as "Longstaff's Pass," by Tilman, Dr. Longstaff very typically refuses to accept. The restrained description of his great moment is equally typical, and all the more effective for the restraint. "We were the first human beings to stand on the rim of the Inner Sanctuary: the first to look down into it. There was Nanda Devi itself rising more than 10,000 feet above the westward flowing glacier at its base. Clouds were being blown across the Sanctuary below us and it was hard to make out the topography: though at our own level we gazed on a chaos of the peaks of Garhwal."

The reader is recommended to dig out of its various pigeon-holes the sequence of Dr. Longstaff's season in 1905. The other events of this memorable year come under "Tibet," which is perhaps a slight disadvantage of the regional treatment of the book. Thus he went on to Gurla Mandhata, and he tells very vividly of his "descent by avalanche" of 3000 feet in a minute or two. Here also is to be found the hideous tale of the lost yaks, the days of illness and

starvation, the meetings with *jykpas* or highwaymen. One quotation gives us the measure of Dr. Longstaff's toughness in need, and of his generous understanding when one remembers that two years later he was back in the Himalaya with the same two guides: "Alexis and Henri began to flag. . . . They asked how I could go on walking without food. I answered 'because I must,' and that anyone could do anything if he'd got to."

And so in 1907 all the credit for Trisul goes to the Brocherels and none to himself; no summit of comparable height having been climbed until a quarter of a century later, and then only with far better equipment and higher camps. "Those were primitive days; we climbed in tweeds." The significance of his casual comment will be realized by anyone who has gone out of his tent into wind above the 20,000-foot mark, without his modern windproof.

The rest, including the discovery of the Siachen Glacier in High Asia, is the story of the small expedition, of the kind which the Shiptons and Tilmans are to this day carrying through so successfully. They would be the first to acknowledge, with many lesser travellers, their debt to Dr. Longstaff; and the later chapters on Greenland and Spitsbergen even more reveal, involuntarily, the unique influence of this remarkable man on a younger generation of travellers.

Apart from what it shows us of his achievements, this is a book of high literary quality. Only a pedant would quarrel with the rather large number of minor inconsistencies of spelling (he might however at least decide whether it is to be the Rhamani or the Rhamini Glacier since he chose the name himself). The point is that as a considered record, the book is a triumph of proportion and judgement. So, if Dr. Longstaff has been an unconscionable time in coming to life on our bookshelves, as it was his plain duty to do, yet in the result the wait has been worth it many times over. T. A. BROCKLEBANK

DAVID'S WORK IN AUSTRALIAN GEOLOGY

THE GEOLOGY OF THE COMMONWEALTH OF AUSTRALIA. By the late Sir T. W. EDGEWORTH DAVID. Edited and much supplemented by W. R. BROWNE. *London: Edward Arnold*, 1950. 3 *vols.*, $9\frac{1}{2} \times 6\frac{1}{2}$ *inches;* xx+iv+1365 *pages*+1 *volume of folding maps; maps, diagrams and illustrations.* £12 12*s*

ON THE DEATH of Sir Edgeworth David (one of the Society's Gold Medallists) in Sydney in August 1934, the completion and publication of the book on the geology of Australia, upon which he had been engaged for many years, became questions of public concern. The Government of New South Wales promptly bought the manuscripts and arranged for the completion of the work by Dr. W. R. Browne of the University of Sydney, to whom David's intentions were best known. The choice was wise, and Dr. Browne has discharged his difficult task with fidelity and devotion beyond praise.

During the past thirty years geological investigation has been gaining in momentum in Australia, where three new universities have been founded and new technical publications established. In all States, both the official geological surveys and the academic authorities have contributed markedly to the advance of geological knowledge, while both Federal authorities and private interests

have sponsored investigations of great importance. Dr. Browne had consequently to take into account a remarkable body of work done since David died, and to this extent has had to make part of the book his own. It would therefore be fitting were it to become known as "David and Browne's Geology of Australia."

The book is essentially what David meant it to be, a coherent and detailed interpretation of all that is now known of the geology of the Commonwealth of Australia and of Australian New Guinea. The first volume deals with the historical geology of the region, the second with its geomorphology (called physiography in Australia) and its economic geology, while the third contains the geological map. The map, first published in Australia in 1931, was re-issued in 1932 with an accompanying volume of explanatory notes, and was then reviewed in the *Journal* (80 (1932) 453). It is now produced again, without change except for the addition of a special sheet for New Guinea, which conforms neither in projection, scale nor colour-scheme with the other sheets. To the comments on the cartography made in the original review there is nothing important to add; but it must be stressed that the map represents the views of 1931, whereas the text represents those of 1950. The map should not therefore be used without constant reference to the text. As the differences between the two lie mainly in the interpretation of geological systems rather than in that of geological stages, no geologist will have difficulty in relating the map properly to the text; but an unwary geographer might easily be misled. The danger could be avoided in a new edition of the book were some indication given at places in the text where it disagrees with the map.

To the geographer, the most valuable part of the whole work is undoubtedly the section on geomorphology; but to the geologist, the map, with its marginal sections, is the essential part of the presentation of the geology of Australia. And it is primarily David's work, its production possible only to a huge, official geological survey—or to a rare individual such as he was. Australia is a federation of states in each of which certain official activities can proceed with little regard to what is being done in the other states, and with but slight possibility of centralized coordination. As Sir Thomas Holland said before the Geological Society of London in 1934, "Australia alone among the Dominions has no Commonwealth Geological Survey. Providence has however lent it temporarily the services of Sir Edgeworth David, who is possibly the only man living who could have correlated the scattered State records to produce a geological map of the whole Commonwealth like that he published two years ago. (*Proc. Geol. S.*, 1933–34, xc.)

We who studied under David thirty to forty years ago, can now discern some of the great changes in our understanding of Australian geology which have occurred since then. Chief among them I would rank the growth of our knowledge of glaciation in Pre-Cambrian, Carboniferous, Permian, Cretaceous and Pleistocene time; the greater certainty in the correlation of Upper Palaeozoic and Mesozoic rocks (the non-committal terms Permo-Carboniferous and Trias-Jura have disappeared); the great increase in the knowledge of fossil insects; the tracing of organic remains down into Pre-Cambrian horizons; the recognition of the relative ages of existing land-surfaces; and the abatement of controversy over the origin of the water in the Great Artesian Basin.

The book has faults, of which some belong to this kind of publication generally, while others correspond to gaps in knowledge. The separate treatment of historical geology, geomorphology and economic geology leads to avoidable duplication of reading. For a full understanding of the Permian record, for instance one has to turn from vol. i to the chapters on coal in

vol. ii. Reference to plates and figures by number without page-number leads to irritating waste of time. A locality-index is badly needed. Numerous places are mentioned which only an Australian geologist will readily find on maps. And there are not enough rock-names in the indexes. I have tried to trace glaucophane schists, which I believe to occur in Queensland, but find no reference to them. The geophysical aspects of Australian geology have been relatively neglected. There is no systematic consideration of terrestrial magnetism, isostasy, or gravity, although gravimetric observations were made in Australia as early as 1793 ('Viaje . . . alrededor del mundo por las corbetas *Descubierta* y *Atrevida* . . . desde 1789 á 1794,' *Ed.*, P. de Novo y Colson, Madrid, 1885). There is no systematic consideration of earthquakes, of which Australia has an interesting record. Little work seems to have been done on the composition of river-waters or of spring-waters other than those from artesian sources. And very little work indeed has been done on the radio-activity of Australian rocks. The book is nevertheless a masterly survey of a huge area, and, with its admirably selected plates and clear maps and diagrams (not the least important of which is on the end-papers), it will preserve its authority, and will serve as a quarry for lesser men than David, for decades to come.

It has importance, too, beyond that of a mere source of information. Some of us who had the privilege of associating with David now see him in the perspective that reveals the man of genius; of interpretative rather than creative genius, for I doubt that he contributed anything original to principle or method in geology. But his thought was exceptionally clear, nimble, penetrating and bold. He would quickly discern the order within complexity, or the relationship between things apparently unlike or far apart. He had, too, a subtle but generous understanding of his fellows which brought the very best out of them. The moral and intellectual proportions of the man were indeed heroic. His qualities made him not only a brilliant geologist but also one of the most prominent figures in the Australian public life of his time. Everybody believed in him. It is therefore disappointing to read page after page of this book but to detect only faintly and here and there the authentic tone of David's ardent, resonant delivery. It would have been wrong for Dr. Browne to have tried to imitate David's style, displayed to advantage in the "Account of the first journey to the South Magnetic Pole" in Shackleton's 'The heart of the Antarctic' (London, 1909, vol. 2, 73–222) and in his official reports from the Western Front quoted by Professor W. B. R. King (*Geogr. J.* 54 (1919) 206–8, 209). It is perhaps enough—indeed, it is rare enough—to have a work of science produced in clear, impersonal English. In this work however we would like to know how much is David and how much Browne, but the two are inextricably combined.

Few men submitted more readily to criticism than David. As he himself has related, "Cotton, Browne, L. L. Waterhouse and G. D. Osborne [his colleagues at Sydney] are helping me most loyally and splendidly, but every Thursday afternoon they constitute themselves into a Board of Examiners, and I have to appear before them to defend my last week's work on the book" (M. E. David, 'Professor David,' London, 1937, p. 306). Several years earlier he had said to me, "They're very stern with me, Aurousseau. I have to prove everything." His humility in accepting this criticism has deprived us of report of some of his courageous speculation. The account, for instance, of the way in which the Australian land-mass has come to be as it is and where it is, is based upon a conception of persistent if slowly migrating, marginal geosynclines, but with little regard to the regions due south of Australia. The scheme accounts well for the distribution of marine organisms in different geological periods. But

the real test of a geological explanation of the dispersal of organisms is its ability to account for the distribution of the land-plants and animals of the present day. The late Professor Launcelot Harrison of Sydney read a classical paper on "The composition and origins of the Australian fauna, with special reference to the Wegener hypothesis" (*Rept. 18th Meeting, Australasian Assoc. Adv. Sci.* 1926 (1928), 332–396) at a time when David was in England. Harrison, whose work has never received the attention it deserves, has shown that the present puzzling distribution of a large number of Australian genera might be satisfactorily explained by acceptance of the hypothesis. What David thought of Harrison's work (if he knew of it) I do not know. David had accepted Suess's scheme of geotectonics and was, indeed, one of the revisers of vol. iii of 'The face of the Earth'; but he became deeply though cautiously interested in the Wegener hypothesis. He once told me he had tested Wegener's claim that certain continental outlines would fit together, by cutting them out and piecing them together on a globe. "And would you believe it," he said, "the astonishing thing is that they *do* fit." His opinions on the question do not appear in 'The geology of the Commonwealth of Australia.' R. W. Fairbridge, nevertheless, agrees tacitly with Harrison that former connection of some kind between Australia and Antarctica must be assumed (*Scope*, July 1949, pp. 25–33); and Lester King now maintains that the oldest land-surface in Australia is evidence of former (Gondwana) connection with southern Africa (*Proc. R. S. Victoria*, 62 (1950) 79–95).

It is important that as much of David's own opinion on problems of Australian geology as can be ascertained should be known. The history of the development of his book should therefore be studied. It began earlier than Dr. Browne supposes, for some of David's students knew, in 1911, that the Professor was busy on a book about the geology of Australia, to be completed in three volumes, of which the first was said to exist in draft. His general accounts of the geology of the country, prepared or edited for the Australian meeting of the British Association in 1914 ('Federal Handbook on Australia,' pp. 241–325; 'Handbook for New South Wales,' pp. 567–619), that in 'The Australian Encyclopaedia' (Sydney, 1925–26) and his 'Explanatory notes to accompany a new geological map of the Commonwealth of Australia' (Sydney, 1932), probably represent successive drafts for the projected book. It is to be hoped that the manuscripts on which Dr. Browne worked will become freely available to students of the history of science in Australia.

That a properly integrated and most acceptable book should emerge from the joint but successive work of David and Browne is matter for wonder, and greatly to the credit of Dr. Browne, for he and David were opposed in temperament as the classical is opposed to the romantic. It is a book which raises a curious question for geography, for most Australian geomorphologists were trained in the geology schools of the universities and are disciples of W. M. Davis. At Sydney, David was both Professor of Geology and Lecturer in Physical Geography. Sydney now has an independent department of geography. Who is to train the geomorphologist, and where will his allegiance lie?

M. AUROUSSEAU

REVIEWS

EUROPE

BIRMINGHAM AND ITS REGIONAL SETTING: a scientific survey. *Birmingham: British Association,* 1950. $9\frac{1}{2} \times 6\frac{1}{2}$ *inches;* xix + 334 *pages; maps, diagrams and illustrations*

For its specific purpose as the customary scientific survey issued by the British Association for its annual meeting, this volume sets a new standard of excellence in appearance, format and content, while providing for general purposes a regional study of the kind long awaited among geographers in this country. It is a work of sound scholarship planned and produced largely by members of the Department of Geography in the University of Birmingham under the direction of Professor Kinvig and the honorary editorship of Mr. M. J. Wise. The considerable team of authors, including a number of specialists not directly connected with the Department are to be congratulated upon their achievement.

Unlike many of the Association's previous and less handsome handbooks, this one holds consistently to a central theme—the evolution of the Birmingham area as a distinctive region, an objective which, as Sir Raymond Priestley suggests in his foreword, enables it to serve not as a guide in the ordinary sense but as a serious contribution to the appreciation and discussion of local problems. The scope and treatment are indicated by the four main divisions of the work: the physical background, the evolution of settlement before 1700, the industrial revolution, and the modern regional and economic pattern. Included in the last section are particular studies of Birmingham itself, the Black Country, Cannock Chase and the east Warwickshire coalfield as constituent industrial units within the region. These, like much of the rest of the book, very properly reflect the strength in historical geography associated with the Birmingham Department. The text, which is well documented and accompanied by over seventy excellently drawn maps and diagrams, contains a few obscurities such as the reference to the fall in the bed of the Trent above Nottingham (p. 45) and that to woods of low economic value on land unsuitable for farming (p. 85). But these are minor blemishes in a work in which the various specialist contributions are so successfully coordinated.

On a point of nomenclature which has been raised before, one may again question the validity of the term "east Warwickshire coalfield." This mining area lies in the north-central part of the county and there is no other coalfield with which it might be confused. It is strange too that while the relevant section is given this title it is referred to in the text and on some of the maps simply as the Warwickshire coalfield, as indeed it was called in the first Memoir of the Geological Survey, published in 1859, and more recently in the Report of the Ministry of Fuel and Power of 1945 and the Geological Survey Wartime Pamphlet of 1948. K. C. E.

A HISTORY OF THE ISLE OF MAN. By R. H. Kinvig. (2nd edition.) *Liverpool: University Press,* 1950. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* viii + 180 *pages; maps and illustrations.* 7*s* 6*d*

ISLE OF MAN. By E. H. Stenning. (The County Books series.) *London: Robert Hale,* 1950. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xiii + 448 *pages; map and illustrations.* 15*s*

These two volumes are the most recent and up-to-date accounts of the Isle of Man, both are excellently produced and well illustrated and very good value.

The Ordnance Survey map will be needed with both, for those unacquainted with the Island's topography.

Professor Kinvig's work—a second edition—is now published under the auspices of the Isle of Man Government by the Manx Museum and Ancient Monuments Trustees. The book seems to be intended for the use of older school-children in the Island, as well as for the general reader. The author is to be congratulated on his success in providing in such small compass so much reliable and first-hand information on the political, social and religious aspects of the Island's story; while prehistory, for which the Island offers ample scope for study, has been adequately treated. Of more immediate interest to geographers are the chapters on "The physical and human background" and on "Chief industries and population"; although even in a book of this scale, neither is sufficiently critical or complete. The relief map (page viii) is good of its kind but the scale is too small for adequate identification of the many topographical references. Since position is as important as structure in explaining the significance of this community, the map on page 52 might with advantage have been placed earlier, and made the subject of relevant comments. The other seven maps serve their purpose admirably. A full if uncritical list of references is appended to each chapter, and there is a helpful if somewhat slender index.

Canon Stenning's book is in the nature of a collection of well-informed and readable essays on almost every aspect of this island community, supplemented in the form of appendices with data not easily obtainable elsewhere. The book should serve as an excellent guide to the intelligent inquirer, and provide entertaining reading for the Island's many friends and acquaintances. There is an index of a sort, a rather inadequate sketch-map, but no bibliography or list of books for further reading.

The Isle of Man should be a breeding ground and training centre for geographers, naturalists and social historians, together with students of their contributory and related disciplines. If these two books persuade any that the field is worthy of cultivation—as indeed it is—then they will have more than fulfilled their primary purpose. We await with interest the publication of the Birmingham University research studies on the historical geography of the Island.

W. L. H.

ASIA

BEYOND THE CASPIAN. By DOUGLAS CARRUTHERS. *Edinburgh: Oliver and Boyd*, 1949. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xx+290 *pages, map and illustrations.* 22*s* 6*d*

Mr. Carruthers' unassuming but admirable accounts of his wanderings in Central Asia before the First World War can hardly fail to arouse in the contemporary reader a feeling of wistful envy. For the vast, fascinating and little known regions of Russian Central Asia through which he roamed without serious let or hindrance have long been out of bounds to the English traveller; and the spacious days in which a private individual could devote half a decade or so to unsubsidized exploration seem sadly remote. A remarkable traveller and a brilliant naturalist, Mr. Carruthers made the most of opportunities which, so far as his countrymen are concerned, seem unlikely to recur; and in this book he throws much fresh light on the less accessible parts of a whole which has ceased to be accessible at all.

It was a wonderful life that he lived. Returning to his base in the Farghana from a solitary and successful quest for *Ovis poli*, he notes "I had been out fifty days, covered roughly eight hundred miles on horseback, fired two cartridges,

and brought back two valuable trophies." In a straightforward, unsentimental way he conveys something of the powerful charm which a nomadic existence had for him. He gives excellent accounts of many strange experiences. He rode down wolves with Kirghiz shepherds and their dogs on steep mountain sides—a sport which must have many of the attractions (and risks) of pigsticking. He watched, with an already knowledgeable eye, eagles being flown at a variety of animals and observed the similarity of their techniques and temperaments to those of goshawks. And his chapter on pheasants throws what will be to most people new light on the origins and distribution of *P. colchicus* and his numerous relations.

In short, this book, which is well produced and handsomely illustrated, will give great pleasure to all who are interested in or curious about Central Asia. Mr. Carruthers is a workmanlike rather than a graceful writer; and it is not easy to identify those passages, referred to by Dr. Bannerman in his foreword, "which would make Noel Coward himself green with envy." But 'Beyond the Caspian' tells in simple words of strange places which few if any of our countrymen have seen; and it is assured of an honoured place in the literature of Central Asian travel. R. P. F.

THE MIDDLE EAST: a political and economic survey. *London: Royal Institute of International Affairs*, 1950. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xvi + 496 *pages; maps.* 35*s*

This is a most valuable book, well produced, thorough and objective. The introductory section, a sketch of the historical, religious and social background, and of the contemporary problems of the Middle East as a whole, is an admirable summary which might usefully be published as a separate booklet. It is followed by detailed country by country surveys. The three maps are models of their kind.

The reviewer's first duty is to call for a second, revised and up to date, edition of the book; throughout the present edition one is constantly and sharply reminded that a long time elapsed between the writing of the various sections and their publication. In a new edition some small errors of fact and phrasing (as well as misprints) should be rectified. Such errors are found on page 419—the Circassians of Jordan are Sunnis, not Shiites; and, on page 108, it is unfortunately not true that the frontier between the Aden Protectorate and the Yemen is "properly delimited," as the Beihan incident has shown.

Faults of omission are more debatable matters, but one might suggest that sections on agricultural problems and land tenure are incomplete in which the effects of Moslem laws of inheritance are not discussed. No account of Muscat and Oman, however brief, should omit mention of the fact that the Sultan's writ does not run in vast tracts of the interior. A discussion of the Egyptian economy might note the current difficulties facing industry, and in particular the fundamental divergence of interest between cotton growers on the one hand and, on the other, manufacturers whose first concern is to provide low cost textiles for their large but poverty-stricken internal market.

Finally, a few doubtful points might be reconsidered, such as Mr. Hourani's unsupported and unqualified statement on page 403 that "Rainfall (in Syria) could also be increased by proper measures of reafforestation."

Such criticisms are however of small importance in comparison with the achievement represented by the work as a whole, which will clearly become a standard handbook for both specialists and general readers. N. N. L.

THE RISE OF RUSSIA IN ASIA. By DAVID J. DALLIN. *London: Hollis and Carter*, 1950. 8×5½ *inches;* xi+293 *pages; maps.* 18*s*

Dr. Dallin's latest book is a companion volume to his 'Soviet Russia and the Far East,' which first appeared in 1949. Together the two books present a detailed survey of Russian policy in Asia, and more especially in the Far East, since the middle of the nineteenth century. The subject is treated as a continuous narrative, 'The Rise of Russia in Asia' dealing with the period prior to 1931, while 'Soviet Russia and the Far East' takes up the story from the time of the Japanese invasion of Manchuria. This division appears to be purely arbitrary, but it is none the less abundantly clear that Dr. Dallin does not regard the Revolution of 1917 as constituting the major dividing line in the sequence of events with which he deals. On the contrary, his argument throughout is that the constancy of geography is necessarily reflected in historical repetition.

His opening sentence in 'The Rise of Russia in Asia' provides the theme for both books: "Three fundamental factors make up the framework of Russian policy in Asia: first, the great political vacuum in the vicinity of Russia's eastern borders; second, the peculiar configuration of Russia proper; and third, the basic divergence in the recent evolution of China and Japan." The first of these factors, the political or power vacuum, is essentially the same as the familiar concept of the heartland, though the author makes no reference to Mackinder's writings on this subject. Indeed, despite the very considerable weight rightly given to the geographical factor, the amateurish treatment of it betrays an almost complete lack of acquaintance with expert studies in this field, and the maps are far from satisfactory even by non-professional standards.

Nevertheless, and quite apart from the intrinsic fascination of the historical narrative, the geographer will find a great deal of extremely useful material in Dr. Dallin's book. The comparison between the demographic history of Far Eastern Russia and other pioneer fringes within the Pacific basin is particularly interesting, as is the revelation of Haushofer's indebtedness to the writings of Sun Yat-sen. The appearance of the book at the present critical juncture in the history of Russian influence in east Asia is, it need hardly be said, exceptionally timely and, notwithstanding the author's somewhat journalistic approach to the problems involved, no reader can fail to be impressed by the astonishing combination of dramatic conception and squalid diplomacy which has characterized the Russian *Drang nach Osten*. C. A. F.

SOUTHEAST ASIA. By E. H. G. DOBBY. *London: University of London Press*, 1950. 8½×5½ *inches;* 415 *pages; maps, illustrations and diagrams.* 18*s*

Professor Dobby's book is a pioneer work which fills a considerable gap in geographical literature; before its publication there was no modern, comprehensive geography dealing solely with the important region of peninsulas and islands lying between India and China. Professor Dobby, who holds the Chair of Geography in the University of Malaya, is well qualified by residence and travel to write about South-east Asia, although his task cannot have been an easy one in view of the present disturbed state of the area. He has produced a book which will be of interest not only to geographers but also to historians, orientalists and others.

The book is divided into three parts. The first "The natural landscape of South-east Asia" contains five chapters dealing with the physical environment; the second is called "The countries of South-east Asia" and deals with the physical and human elements in the geography of the major political units; while the third "The human geography of South-east Asia," contains four

chapters on agriculture, fisheries, industry and trade, and "peoples, politics and prospects" respectively. All chapters are well illustrated with maps and diagrams although cartographical details could be improved (*e.g.* the shading on the geological map on page 89 is not sufficiently graphic).

Apart from the fact that it fills a very large gap, a number of points about the book call for praise. The landforms are often very clearly described, and their relation to hydrology and to irrigation are well demonstrated. The myth of the fertility of the general run of tropical soils is again laid low. Variability and unreliability of rainfall in such areas as the Dry Zone of Burma are rightly stressed, though more precise statistical support might have been given. And the importance of Dutch influence on the economic geography of Java is well brought out in Chapter 14, which may serve to correct the conventional opinion that the pre-eminence of Java over its neighbours is solely due to soil and climate.

Professor Dobby's book has however some serious defects. In the first place there are errors and omissions of fact and interpretation. Few geologists would now accept the Nanling as an Alpine range continuing the line of the Himalaya, and—*pace* Suess—it is misleading to call the pre-Alpine structures of Malaya and elsewhere "ancient," when most of them appear to contain Mesozoic elements; in fact, tectonic matters are usually over-simplified and not enough is made of the fact that many things are still uncertain. It appears that Professor Dobby has not used the syntheses of recent knowledge made by Umbgrove in 'The pulse of the Earth' and in his 'Structural history of the East Indies.' Again the discussion of population pressure and colonization in the East Indies seems not to take into account the findings of Pelzer in his 'Pioneer settlement in the Asiatic tropics,' though the title of the work is quoted (wrongly) in the bibliography for one of the concluding chapters. The role of the Karens in the colonization of the Irrawaddy delta is not mentioned.

In the second place there are faults of English usage. "Peneplainisation" is an ugly substitute for the euphonious and usual "peneplanation", and "estuarial" seems unnecessary. "Chemical" is used where "substance" is meant and "ecology" for "economy." Some phrases appear so often that it is possible to call them jargon; though one would not go so far as one reviewer who considered the term "human geography" to be jargon.

More important however are faults of arrangement, organization and integration, qualities which lie at the heart of the great problem of writing good regional geography. For instance Professor Dobby plunges after a very brief foreword into his account of structure and relief; some discussion of the definition and character of his region, especially in terms of space-relations, would have been very useful. Again, the regional accounts of Part II are preceded by a review of physical factors in South-east Asia, but no general review of human factors is given until Part III, so that the reader finds he is unable to decide on the wider significance of such factors in a given region while reading about the region itself. A few chapters, comparable in scope to those in Part II of W. B. Fisher's recent book on 'The Middle East,' would have been both logical and useful, and might have dealt systematically with such topics as ethnic divisions, technological levels, Chinese and European influence and so on. Such a general survey of historical, social, political and economic factors is especially necessary in South-east Asia, where so many political frontiers are unrelated to human distributions.

The chapters themselves, especially in Part II, lack integration, and there is considerable repetition. This is partly due to the plan of describing most regions in terms of "physical landscape," "cultural landscape," and "social

geography," which necessarily overlap considerably. Many geographers moreover, would not accept the implicit assumption that their subject is concerned with landscape, natural or cultural, and Professor Dobby does not seem very sure himself. He uses the word "landscape" with almost distressing frequency in his chapters on Malaya, but writes of some other regions in more conventional terms. B. H. F.

CEYLON: Pearl of the East. By H. WILLIAMS. *London: Robert Hale*, 1950. 9×6 *inches; 460 pages; end-paper map and illustrations. 25s*

Mr Williams was a tea-planter in Ceylon for many years, and writes informatively and with imagination about the land in which he spent his working life. He is at his best when describing the tea industry, a partnership between European and Tamil that has brought so much wealth to the country. Mr. Williams has observed the Sinhalese with care, he knows the jungle, and is more than superficially acquainted with both the long history and archaeology of ancient Ceylon. Except for the political aspects of this newest dominion, which he wisely omits, the author is a reliable, though not infallible, guide. At times his power to dramatize an incident, as in the Introduction—Turnour's self-dedication to the editing of the Mahawansa—leaves a more than transitory impression upon the reader. The sensitive account of his first nocturnal visit to Anuradhapura imparts a high quality to his pages.

Mr. Williams' book, though not autobiographical, is essentially a personal appraisal of Ceylon; and we are invited to share his appreciation of the scenery and indigenous culture, and his prejudice against political and social change. It is evident indeed that the new regime springs from Britain's failure to create a single community, a failure that arises partly from distrust within the dominant group. As in many colonies there was antagonism between missionary, administrator and planter; and this is clearly revealed, albeit quite unconsciously, in Mr. Williams' wholly unsympathetic account of British rule in Ceylon.

There are not infrequent errors which could have been avoided had the MS. been read by an orientalist: for example, the statement on page 11 that Pali is ancestral to Sanskrit. Furthermore the author readily oversteps the borderline between good writing and journalistic over-statement. But within its chosen limits this book is to be welcomed as a contribution to geographical understanding. J. H. G. L.

HISTORICAL RECORDS OF THE SURVEY OF INDIA. Vol. 2, 1800–1815. By Colonel R. H. PHILLIMORE. *Dehra Dun: Survey of India*, 1950. 12×8½ *inches;* xxviii+478 *pages; maps and illustrations. Rs20* or *£1 11s*

This is the second volume of Colonel Phillimore's great history of the Survey of India, the original documents and maps of which he began to investigate some seventeen years ago. The first volume was reviewed in the *Journal* three years ago (111 (1948) 121). The present volume is of even greater interest, since it covers perhaps the most important fifteen years in the East India Company's expansion, and certainly the most important years of the Survey; it was during this period that Lambton began the trigonometrical survey of India. In the north, a Resident in Oudh was appointed by Treaty in 1801; the districts of Gorakhpur, Rohilkhand and the Jumna-Ganges Doab were ceded to the company by the end of the year: expansion reached the Sutlej by 1809; while the Nepalese War of 1814–15 altered Himalayan boundaries and opened the Central Himalaya to exploration. In the south the victory at Seringapatam in 1799 laid open an immense tract to peaceful survey. On the west Gujarat, Berar and Sind were penetrated.

Just as the history of eighteenth century survey in Bengal centred around James Rennell, so in the north it centres around Robert Colebrooke, Surveyor-General of Bengal from 1794 to 1808. It was not easy for Colebrooke to plan ahead. Frontiers were always changing; Government priorities for maps varied, and surveyors were constantly being reverted to military duties at critical times. Maps of lower Bengal required constant revision because of river changes and work in the Sundarbans was impeded by dacoits, tigers and heavy seas. The penetration of the Himalaya and the exact sources of the Ganges and Jumna were matters of absorbing geographical interest; these riddles were solved during the period and were Colebrooke's responsibility. When short-handed he took the field himself, and finally fell a victim to dysentery after thirty years' service in India without a break of leave outside the country. He was succeeded by John Garstin whose interests included remedial measures for river changes in Bengal.

In the south two outstanding figures of world-wide reputation were Colin Mackenzie and William Lambton, respectively the greatest topographical surveyor and the greatest trigonometrical surveyor of their day. While Mackenzie planned and surveyed the whole of Mysore (roughly 52,000 square miles) together with neighbouring states, Lambton methodically measured base lines and covered the southern half of the peninsula with geodetic triangulations of great accuracy. Both men were masters of organization, tact and perseverance; the ghost of their reputed rivalry is successfully laid by Colonel Phillimore's quotations from original letters. Of extraordinary interest are Mackenzie's instructions to his surveyors and the collection of reports on almost every aspect of the country, its peoples, forests, zoology, and what we would now call "land utilization." These were the foundation for the revenue surveys and land settlements that followed afterwards. Maps and reports were often made in triplicate, a fortunate precaution since one set of maps was destroyed in 1804 when the *Prince of Wales* was lost at sea.

Chapter 12 deals with the work of the Bombay surveyors, mostly route surveys in the disturbed Maratha Deccan, Kathiawar, Gujarat and Cutch, but the chief interest lies in the Persian missions (Malcolm's in 1800 and 1808, Christie's and Pottinger's in 1801 among them) which were the outcome of Napoleon's projected invasion of India. Chapter 13 deals with Revenue Surveys, and Chapters 14–20 cover methods of survey, the control of error and description of instruments, maps, administration, etc. The sections on "Care of Health" and on "Men and Manners" well illustrate the conditions of the times. Some 80 pages at the end are given to biographical notes of more than 200 individuals; these contain a great deal of new material from original sources and must have entailed a vast amount of research. The whole volume is packed with interest for the historian or geographer of India; samples of many beautiful maps are excellently reproduced and there are little-known portraits of most of the leading men; the text is fully documented and there is a very complete index.

K. M.

AFRICA

THE SURVEY OF EGYPT 1898–1948. Edited by G. W. MURRAY. *Survey of Egypt Departmental Paper No.* 50 (*English Edition*), 1950. 13×8 *inches*; 94 *pages*

This is a useful but very brief record of the first fifty years of the Survey of Egypt, which was founded on 8 June 1898 with the fusion of the old Revenue, Hydrographical and Geological Surveys with the Drawing Office of the Ministry

of Public Works, to which was added in 1900 the Astronomical and Meteorological Observatory at 'Abbâsîya. It is presumably intended primarily for departmental officers since, apart from the four fairly detailed chapters devoted to Cadastral Surveys, other sections are inadequately dealt with, Chapter 9 (The Geodetic Survey) being limited to two pages. The account does however show how intensely valuable a small scientific department can be; and how it can overcome or by-pass difficulties where speed of output, as in Land Registration and Land-tax reassessment, is essential. This emphasis is doubtless due to the fact that the Survey operates directly under the Ministry of Finance, where quick and visible returns are desired. Among other activities briefly mentioned are researches connected with irrigation, evaporation in the Sudd region, boundary surveys, archaeological work, the printing of postage stamps, expropriation matters (including compensation) connected with the raising of the height of the Aswân dam in 1912, desert surveys, crop surveys, etc. Systematic planning of topographical work has been interrupted by two world wars, but dangers of invasion helped to stimulate desert surveys—notably the survey of the Siwa–Sallûm–Daba triangle between the Qattara depression and the sea, which was begun after the Munich crisis and completed before Italy's entry into the war. Altogether some 40 per cent. of Egypt's area is now professionally mapped on a triangulation framework on a scale of 1 : 100,000 and only some 34 per cent. has no maps at all. An interesting post-war development is work in Sa'udi Arabia, where bases have been measured at Mecca and Medina, and maps made of these cities at a scale of 1 : 10,000. Summaries are given of the work carried out in both world wars, but it is incorrect to claim that General Maude's maps in Iraq, used for the advance to Baghdad in 1917, were the work of sections from the Survey of Egypt. K. M.

AMERICA

A NATURALIST IN THE GRAN CHACO. By Sir JOHN GRAHAM KERR. *Cambridge: University Press*, 1950. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xii + 235 *pages; maps and illustrations.* 21*s*

PLANT HUNTERS IN THE ANDES. By T. H. GOODSPEED. *London: Robert Hale*, 1950. $9\frac{1}{2} \times 6\frac{1}{2}$ *inches;* xiv + 429 *pages; maps and illustrations.* 21*s*

The first of these books is based on the author's diaries of his expeditions in 1889–91 and 1896–97. He is a distinguished zoologist and the diaries have kept their freshness of outlook. The first expedition had been organized by Captain Juan Page of the Argentine Navy for the exploration of the Pilcomayo, and Kerr accompanied him as a naturalist. His diary is full of descriptions of animals and plants and he gives an account of the extremely primitive society of the Natokoi Indians of the Chaco. The second expedition was expressly organized for the study and collection of the then little known lung-fish, *Lepidosiren*. The whole makes an informative account of the Chaco and provides very pleasant reading.

Professor Goodspeed travelled up and down the Andes collecting plants and seed for the University of California, whose Botanical Garden is introducing to the world new species of horticultural value. He was particularly interested in the genus *Nicotiana* and many species were collected for hybridization. The book describes the author's travels and adventures, and to the more general reader the wealth of beautiful photographs with which it is illustrated will be most attractive. The tropics contain the largest number of plant species, the most exciting animals and most of the more brilliantly coloured birds and

fishes of the world. It is however the south temperate region which seems to have impressed Professor Goodspeed most. He describes masses of scarlet-crimson *Embotheriums* as hurling back the sunlight in a burning red haze, so powerful and so rich that the beholder prepares to shield himself from the expected heat. A. H. G. A.

AUSTRALIA AND PACIFIC

NEW ZEALAND IN OUTLINE: a pictorial geography. By K. B. CUMBERLAND. *Christchurch N.Z.: Whitcombe and Tombs*, 1950. 11×8½ *inches;* 84 *pages; maps, diagrams and illustrations.* 8*s* 3*d*

Mr. Cumberland's work is already known to geographers in this country. His present book is intended for use in New Zealand schools. After a brief introduction dealing with configuration, climate and natural vegetation, he distinguishes ten agricultural regions and describes each in turn, basing the text on a map and on an excellent series of photographs. The same procedure is followed when he comes to consider power, industry, manufacture and transport. The diversity of land forms and the disproportionate length and breadth of the country make this treatment most suitable, and one is left with a clear picture of the islands as a whole. The photographs, of which there are one hundred and eleven, are well chosen and with a few minor exceptions, for example Fig. 110, they are clear and very attractive. The series of maps is perhaps less satisfactory. Scales, which vary considerably, are not given; and maps such as those on page 13 are for this reason unnecessarily difficult of interpretation, while that on page 56 attempts too much. Pupils in New Zealand will of course have good atlas maps constantly before them to supplement the sketch maps, but one would like to see the book in use in British schools where unfortunately maps of New Zealand are usually most inadequate.

The book contains much valuable information attractively presented. At the same time it affords ample opportunity for real teaching, and one can picture lively and interesting discussions developing between teacher and pupils when it is used. G. M.

PHYSICAL GEOGRAPHY

PHYSICAL GEOGRAPHY. By PHILIP LAKE. Second edition, revised by J. A. STEERS, G. MANLEY and W. V. LEWIS. *Cambridge: University Press*, 1949. 9×6 *inches;* xxviii+410 *pages; maps, diagrams and illustrations.* 15*s*

The task of revising Philip Lake's celebrated textbook on Physical Geography has appropriately fallen to three of his pupils: Professor Steers, Professor Manley and Mr. W. V. Lewis. For over thirty years it has remained substantially unaltered as a standard work for beginners in physical geography. The co-opted authors have aimed at preserving as much of the book as possible and well over three quarters of the original work has been reprinted intact. Into the new edition new ideas and new facts have been blended with considerable skill, but a better result would sometimes have been achieved if some chapters had been completely re-written. This flaw is understandable when it is recalled that the authors were particularly anxious to preserve as much as possible of Lake's own lucid and skilful writing. Nevertheless wherever substantial changes were unavoidable the authors should have been more courageous in avoiding the practice of supplementation. This has inevitably led to overweighting in places and to the insertion of modern ideas and facts unaccompanied by adequate explanation and introduction to the beginner. The section

on oceanography may be cited as an example; injected into Lake's dated but clearly expressed hypotheses regarding the nature and origin of the floor of the oceans are vague supplementary sentences and paragraphs referring to modern trends of thought and investigation into submarine erosion and deposition. No attempt has been made to couple with this a modern classification of sediments which a student could use when studying in the field marine deposits of modern or geological age. On the other hand wherever major revision has taken place, as in the description of shore lines, river erosion, underground waters and glaciation, the high literary standard which has been achieved confirms the opinion that a larger portion of the book should have been remodelled. The book has on the whole however escaped the fate of similar long-standing works which have been revised, and it will undoubtedly remain the effective avenue to the detailed study of physical geography so brilliantly conceived by Philip Lake. W. D. E.

CLIMATE IN EVERYDAY LIFE. By C. E. P. Brooks. *London: Ernest Benn*, 1950. 8¼×6 *inches;* 314 *pages; maps and diagrams.* 21*s*

In the course of his professional duties Dr. Brooks has received innumerable inquiries on a wide range of matters of applied climatology, and his purpose in this book is "to provide the answers to the questions that are most often asked about climate by anyone choosing a site, planning a house, factory or new town, starting up or expanding a business, buying an outfit for a journey overseas or engaged on any other activity in which the prevailing weather conditions are an important factor." The emphasis throughout is on the influence of climate on man's life and work, on climate as a friend and climate as a disaster. With this in mind he produces an interesting map of nine types of climate according to their dominant influence, *e.g.* insolation climates, deterioration climates (where man stagnates, metals corrode and things go mouldy), winter frost and snow climates, typhoon and hurricane climates, and so on. But parts of this map are left surprisingly and disappointingly blank because "they . . . show no special characteristics, either favourable or unfavourable." This can hardly be conceded since they include the whole of the East African Plateau, whose suitability as an area for white colonization is hotly debated, the Guianas and the Northern Territory of Australia, some of which lies within the 75° wet-bulb January isotherm recognized (on p. 26) as an important climatic boundary.

These climatic types are however abandoned in the chapters dealing with the regional descriptions. Here "tropical climates" is used in the restricted sense of wet tropical for the climates usually called equatorial. "Sub-tropical" appears to connote climates near the tropics, usually called tropical but here "sub-tropical climates with summer rain" and the possession of this rainfall quality necessitates their extension to embrace the monsoon regions, so that they range from Rangoon to Sakhalin. Only 60 pages are allowed for these chapters, which are made to bear not only routine climatic descriptions, but also much detailed information about the more spectacular impacts of climate on residents and travellers.

Then follows one of the most interesting chapters; on the deterioration of materials and the growth of moulds in feeding stuffs, and on the temperatures and humidities that develop inside containers exposed to the sun. These effects are of course well known, but here an exact and scientific treatment replaces the old generalizations. The chapter on atmospheric pollution exposes this disgrace in all its sordid grimness. In the last two chapters, heating, air conditioning, lighting and clothing receive attention, and the possibilities are

assessed of influencing the weather by rain-making, fog dispersal, hail-shooting, lightning conduction and frost prevention.

Inevitably there are many tantalizing omissions and much over-compression, but in a book which provides so much in small compass it would be unreasonable to expect more, and there is a bibliography of over 150 articles and books. These include references to obscure and foreign journals, which makes some of the omissions the more surprising. For example, although much is said of microclimatic effects, there is no mention of Geiger's summary in 'Mikroklima und Pflantzenklima'; and though the theories of the Ellsworth Huntington school of climatic influence on health and character are freely accepted the physiological work of Mills and of Winslow and Herrington in the U.S.A. are ignored.

Nine pages of climatic tables are provided, including a convenient assembly of data on relative humidity and days of rain; but temperature is only given for January and July, which conceals rather than reveals the temperature characteristics of low-latitude climates, and rainfall is given only for the wettest and driest months, which is quite inadequate as an indication of rainfall regime. The "wettest month" at Edinburgh is August, but at Aberdeen it is December; their rainfalls are not really so wide apart. A. A. M.

CARTOGRAPHY

ATLAS INTERNATIONAL LAROUSSE POLITIQUE ET ECONOMIQUE (with text and legends in French, English and Spanish). Edited by JEAN CHARDONNET. *Paris: Librairie Larousse* (*London: Harrap*), 1950. $19\frac{1}{2} \times 13\frac{1}{2}$ *inches; 58 plates; text and index.* £7 7*s*

In his introduction to this new atlas, André Siegfried writes eloquently and forcibly of the changes which in recent years have revolutionized the economic and political geography of the world—among them the great increase in the speed of communications and the development of air routes; the consolidation of a few great powers (he considers the requirements for a great power to be 8–10 million km.^{2} of territory and a population of 150 million), inducing in the smaller powers a tendency to form counterbalancing groups; and the consequent need to take a world view in politics, economics and strategy. The atlas is designed with these considerations in mind: it is international, with text and legends in French, English and Spanish; it employs projections not usually found in such works; it concentrates on regions rather than individual countries. These are some of the claims advanced: to what extent are they justified?

The atlas begins with three physical maps: the northern hemisphere on a modified polar zenithal equidistant projection, and the old and new worlds on Mercator's projection. Then comes a section of political maps, followed by the economic maps. The polar map certainly brings out the relationship of the land masses, but an equal area projection would have shown this and avoided the exaggerations of area at the equator. The physical maps are agreeably printed in eight colours: the political maps, with frontiers shown by coloured bands, contain information in diagrammatic form on exports and imports. The detailed economic map of France on a relatively large scale (1 : 1,625,000) is a striking production. The economic section includes maps of the world or of large units showing sources of energy, mines, agriculture, heavy industry, air lines, population, etc. On the back of each map is a commentary printed in the three languages, and the volume is completed by an index and statistical tables.

It is clear therefore that a great amount of information of one kind or another has been collected, classified, and set down on the maps. The general factors are well brought out, but an examination in detail of the British Isles suggests a certain amount of hurried work and misunderstanding. When a few names only can be shown, it is important to choose the most significant. Some have got on to the map for obscure reasons, *e.g.* Grosmont, Yorks; Honeybourne, Worcs; and Parkmore, Antrim. Gillingham, Wilts, has been confused with Gillingham, Kent, and shown as a town of over 50,000 inhabitants. There are also too many spelling slips, *e.g.* Barkins (Barking), Kitney (Witney), Rinsale (Kinsale). On the heavy industries map, a zone is shown as extending unbroken from Liverpool to Hull. Errors are also to be found on other maps: on that of the northern hemisphere for example, a line is inserted across land and sea, labelled "Limite des glaces permanentes" and "Limit of pack-ice."

Names in the atlas are said to be given "in the language of the country to which they belong," or "in their own national spellings" with cross-references from such English, French and Spanish conventional equivalents as have become established. The scheme is fundamentally faulty, because many marine features which have names in several languages belong to no country; and because names can be given in their national spelling here only if they happen to be in the Roman alphabet. Brazilian names fulfil the conditions, but are here given in obsolete orthography, and with many hyphens not used in Brazil. Names officially written in non-Roman scripts have all to be transliterated or transcribed, but it is hard to discern any sign of a policy for rendering them consistently. Russian names appear quite satisfactorily in French orthography, but the treatment of Arabic names varies according to the country concerned. To Greek names more than one system of transliteration seems to have been applied. The expressions "Ancient Continent" and "New Continent" appear on several plates, presumably for "Old World" and "New World." The editors seem unaware that the English name of what they have called "North Atlantic Ocean" on Plate 4 is "Bay of Biscay" (which is not the equivalent of Golfe de Gascogne or Golfo de Vizcaya). In the Antarctic, the names "East Antarctic Land," "West Antarctic Land" and "Palmer Land" have been coined, but Victoria land still appears as "South Victoria Land."

Closer examination of names reveals errors of detail. Plate 10 shows the "Salomon" and the "Viti or Fidji" islands. The same plate shows "Harford" (Connecticut), but it would be hard for an uninstructed person to decide to what the name applies, so badly is it placed. On Plate 5 there is a "Gulf of Lion." Similar errors, and slight inconsistencies are numerous in foreign names. On Plate 20, east of Australia, appear three little dots marked Phillip, Kingston and Norfolk. This is *reductio ad absurdum*, Phillip being an insignificant islet, and Kingston, presumably the "capital" of Norfolk Island, is a name never used.

The French text comments lucidly and instructively on the maps, but the English translation has not been well done. There are several passages, *e.g.* on pages 6 and 23a, which are meaningless; "silt" is not the best equivalent of "limon," "routes," for roads, becomes "railroads" in one instance, and on one map "une vingtième" is rendered as 20 per cent.

No one would underestimate the difficulties of producing an atlas on this scale in these days, or wish to criticize the results too hardly; in this case, the general design and the production are good, but much more care should be given to detail in a subsequent edition. It is important to emphasize this aspect in view of the favourable reviews elsewhere in this country. G. R. C.

ECONOMIC AND SOCIAL GEOGRAPHY

GÉOGRAPHIE AGRAIRE: types de cultures. By DANIEL FAUCHER. *Paris: Librairie de Medicis*, 1949. 10×6½ *inches; 382 pages; maps and illustrations.* 24*s* 5*d*

Seldom does an author's preface provide so satisfactory a text for the reviewer, with the essential character of the book exactly stated in a few paragraphs. The book is concerned with the leading types of agriculture, chosen largely on the principle that certain crops are associated, in groups, with particular modes of life. Such combinations depend both upon their adaptation to the environment and upon the many other phenomena that together make up a rural civilization. Hence the types are classified according to the aims and techniques, often despite wide differences in the plants cultivated; moreover, the influences are traced as they have caused the evolution of the various types. Much of the matter belongs also to economic history, but it is given the different emphasis that is expected from a geographer. On the other hand facts which are commonly included in textbooks of economic geography are discarded if they do not help to account for rural landscapes and life. The reader is encouraged to see the cultivators as real people, from the savage gatherer caring for a half-domesticated plant to the expert vine-grower or the wheat-farmer of the prairie. There is much information on biological, technical and tenurial matters which is not easily available in geographical works, but it is introduced only where essential to the theme.

The plan of the book itself is arranged on evolutionary lines. From food-gathering as practised in various climates the author passes to shifting cultivation, including its vestiges in Europe, and then to fixed agriculture with fallowing, and he discusses probable causes for the development of two-field and three-field systems. The Flemish system of continuous cultivation is placed in true perspective; the same applies to the Chinese system, while the ways in which the fallow has been eliminated are related to the various kinds of farming of to-day.

Discussion of the effects of commerce upon agriculture leads to a rather full account of wheat cultivation throughout the world. A chapter is given to the relations of stock-keeping to cultivation, so varied both in time and in geographical distribution, and the growing dependence of stock upon crops specially raised for them. This is followed by a treatment of gardens and orchards, including tropical plantations. Anglo-Saxon readers will appreciate especially the authoritative essay on the vine, a plant which, more than any other, depends upon human skill and attention. The chapter is welcome both for its broad review of wine production and for points of detail; thus, the development of a fine wine is always far older than its reputation, coming as it does from plants that have long been thoroughly adapted to local soil and climate: most of the finest kinds are grown beyond the "natural" area of the vine, and the production of each, from planting to bottling, is governed by local tradition. The interest is fully maintained in the treatment of the so-called industrial crops: as for instance in relating the extraction of products from trees to the raising of ground-crops; such things as resin, rubber, cacao and raw silk are dependent largely upon the part-time labour of peasants. Again we see hemp and flax in decline before the advance, elsewhere, of cotton.

The author, in reflection, considers the relative values of agricultural systems and notes that they are weakest where vegetation is most prolific, in the rain-forest, more developed and "supple" under the monsoon climate, but with important exceptions, and most successful in the temperate regions. In Europe

plants have been assembled under cultivation from prehistoric times, a combination of crops and methods that led to the creation of a solid rural society. Agricultural revolutions have come from without, chiefly owing to the introduction of new plants; and the white peoples using the old European systems have been able most successfully to benefit from modern scientific discovery. Thus the traditional peasant with his outlook bounded by his property, "his obscure feeling of being the heir of the marriage of man and the fruitful land" is probably about to disappear. While national exploitation, with its collective methods, is the most revolutionary change in this direction, various forms of cooperation make rapid progress elsewhere. In many ways then, the book is marked by an original approach. It provokes thought and is interesting throughout. It is also very well documented, with a bibliography of some 400 entries; the maps, which are from other works, are clear and like the photographs well chosen. A. G. O.

MAN, SOCIETY AND ENVIRONMENT. By BRIAN HACKETT. *London: Marshall*, 1950. $8\frac{1}{2} \times 5\frac{1}{2}$ *inches;* xiv + 316 *pages; illustrations and maps.* 30*s*

The title of this book hardly reveals its essential theme, which is the development of town life in various parts of the world from the earliest urban communities in the Middle East to the industrial towns of the present day. The range is thus a vast one both in time and space, and the author deserves considerable praise for grappling with so immense a subject within the compass of a book of this size.

He has brought together a mass of information which is presented in a readable and interesting manner; and he strives to bring out how ideas and institutions which are bound up with social and economic factors are reflected in the layout of urban and other units in the past and at the present. Thus there were significant differences between the cities of the ancient world centred on the Indus and those in Mesopotamia. Society seems to have developed more evenly along the Indus than in Mesopotamia and there were no vast temples or palaces to dominate and suggest a concentration of wealth, nevertheless the population was apparently divided into simple classes—the merchants and labourers or artisans. In the modern world the setting-up of new co-operative communities in agricultural areas is noted, as for example, the *Kvutza* of Palestine, the *Kolkhoz* of Russia and the *Ejido* of Mexico. The geographical approach to problems of this kind is not brought out very well; witness for example the rather naive statement in the introduction that "Egypt and Mesopotamia developed in the 'fertile crescent' area simply because the area was fertile."

From the point of view of urban planning there is a crying need for adequate preliminary surveys with the assistance of a team of specialists, and the geographer has indeed a vital role to play at the present day when planning has become a major activity.

The diagrams which are collected at the end of the volume form on the whole a very useful and suggestive series, although some of them suffer from over reduction; but the quality of the maps in the text is poor, and some of them (especially that showing medieval trade routes on page 106) are almost impossible to decipher. R. H. K.

THE SOCIETY'S NEWS

THE QUEEN MAUD LAND EXPEDITION

On Saturday, January 6, at about 8 o'clock in the evening, a knock on the one visible window of the base camp announced to the seven men at Maudheim that the expedition ship *Norsel* had once more succeeded in making her way south through the ice belt, and was a second time anchored in Norsel Bay. The arrival of the ship's party startled those at the base who, after eleven months, had become accustomed to the monotony and isolation of their life on the Antarctic ice shelf. Having left Capetown on December 21 the *Norsel* had made a rapid journey, reaching the pack-ice in 65° S. on December 30. On January 5 reconnaissance by Friis Baastad and Anders Jacobsen, of the Norwegian air unit, showed that open channels could be found to the south-west and, at some distance, channels north and south. The same evening *Norsel* was 240 miles north of Maudheim and making such good progress that Norsel Bay was reached the following day. Three fine days the following week enabled the relief supplies to be unloaded.

Meanwhile work had been going forward on the summer's scientific programme. A subsidiary base was established, by means of "weasel" transport, 185 miles south of Maudheim and here supplies and equipment for eight men and fifty dogs for a four months' stay were being gathered together, involving dangerous and laborious journeys by flotillas of "weasels" dragging laden sledges across the ice shelf. From this subsidiary base, named the "Pyramid," on the rim of the newly discovered mountain ridge about 1500 metres above the surface of the sea, the scientific investigations of the expedition will be carried out during the remaining weeks of the short Antarctic summer. At the same time an intensive air survey programme will be operated from Maudheim itself, as well as from the relief ship as she makes her way north again to the sealing grounds, bringing back the "summer visitors".

Squadron Leader G. B. Walford, who commanded the R.A.F. unit that went south with the *Norsel* in 1949–50, was awarded the Order of the British Empire in the New Year's Honours List for 1951.

THE WORLD LAND USE SURVEY

The International Geographical Congress at Lisbon in 1949 set up a commission to study the possibilities of a world-wide survey of land use. The members of the commission met again in the U.S.A. later in the year and a report of their conclusions and proposals, with an outline of the scheme of classification, was published in the *Journal* (115 (1950) 223–6). The World Land Use Survey that was then proposed may be said to have come into being on 1 January 1951 with the establishment of a headquarters for the Old World division in two rooms at the Society's House. Mr. J. Callow is Organizing Secretary and Mrs Reed his assistant; the division is under the general direction of Professor Dudley Stamp, the British member of the commission.

The immediate tasks of this small unit are to explore and record the availability of published material, both in map sheets and in descriptive and statistical works, on which pilot surveys of land use can be based in advance of the detailed field work which must eventually be undertaken; and to prepare a few specimen sheets and sheet memoirs as a test of the suitability of the scheme of classification drawn up by the commission. It is believed that a considerable volume of suitable material will come to light.

The new headquarters will also establish contact with workers abroad who are able to undertake surveys in the field. Their practical experience will be of the greatest value in the interpretation of local conditions and necessary amplifications of the scheme of classification will be discussed with them; the headquarters staff will always be ready to give advice on specific points. Contacts have already been established in India, Malaya and Nigeria and any individuals or organizations that are interested in the undertaking are invited to communicate with the Organizing Secretary at the R.G.S.

A REPRINT OF TWO PAPERS BY SIR H. J. MACKINDER

The Society has recently reprinted in the form of a pamphlet Sir Halford Mackinder's papers "The scope and methods of geography" (*Proceedings of the R.G.S.* 9 (1887) 141–60) and "The geographical pivot of history" (*Geographical Journal* 23 (1904) 421–37). The former marks a turning point in the teaching of geography in this country, for many conceptions that are now commonplace in geographical thought were introduced by him. The second paper is already well known and its topic, the importance of the "Heartland" in the political orientation of the modern world, was expanded by him in his "Democratic ideals and reality" in 1919; this book was republished in the *Pelican Books* series as recently as 1944, but it has long been difficult to obtain access to the original paper.

These two important papers are now reprinted with an introductory essay by E. W. Gilbert, Reader in Human Geography in the University of Oxford, and a portrait of Mackinder. Copies may be obtained at the Society's House or from John Murray, price 2*s* 6*d*.

EXHIBITIONS AT THE SOCIETY'S HOUSE

The Christmas exhibition, "Bird travellers", was arranged to correspond with the Society's Christmas lectures to young people and remained open to Fellows during January and February. The wall maps illustrating migration routes were specially drawn by the Society's draughtsmen and models were lent by the International Wildfowl Research Institute, the Fair Isle Bird Observatory Trust, the Royal Society for Protection of Birds and the Scott Polar Research Institute. The numerous and excellent photographs which added so much to the attraction of the exhibition were, for the most part, lent by the ornithologists who had taken them. The Society is greatly indebted to Sir Norman Kinnear, a former Director of the British Museum (Natural History), who undertook most of the work of selecting and arranging the exhibits and of preparing the captions to explain them.

Another exhibition, which is being organized jointly by the Society and the Institute of Navigation in connection with the Festival of Britain, is to open at the Society's House on May 3. It is to be an exhibition of British maps and sea-charts of the twentieth century and will include sections on air navigation charts and air survey and a section on Polar maps which will cover recent discoveries in the Antarctic.

ANNUAL VOLUMES OF THE *GEOGRAPHICAL JOURNAL*

Since the *Journal* is now published quarterly, it is felt that the four issues of the year will make a single volume of a more convenient and economical size than the half-yearly volumes in which they are at present bound. The first of the single volumes will be that for 1951 (volume 117), beginning with the present issue. The paging will be continuous and there will be a single annual index and title page which will accompany the December number.

THE RECORD

CONTRIBUTORS TO THIS ISSUE OF THE *JOURNAL*

R. H. Hughes is now serving in Hong Kong in the Department of Crown Lands and Surveys. He was a prisoner of war in Hong Kong during the Japanese occupation of the colony. *Sir Edmund Craster*, Fellow of All Souls College, Oxford, was Bodley's Librarian at Oxford from 1931 to 1945. *D. M. Poole* was for some years Temporary Secretary at His Majesty's Embassy in Mexico City. *Professor Gordon Manley*, a former President of the Royal Meteorological Society, has been Professor of Geography at Bedford College, London, since 1948. He was formerly head of the department at Durham and a Lecturer in Geography at Cambridge. He has travelled in East Greenland. *Thor Heyerdahl* is now famous for his *Kon-Tiki* voyage, which was the subject of an article in the *Journal* a year ago. His views on Peruvian–Polynesian migration were criticized by Professor Heine-Geldern in our last issue and Heyerdahl now replies to the points raised in that paper. He has recently been awarded the Mungo Park Medal of the Scottish Royal Geographical Society. *Brigadier R. A. Bagnold*, F.R.S., a Gold Medallist of the Society and a member of Council, is an eminent desert explorer and author of 'The physics of blown sand and desert dunes.' His present paper supplements Mr. Thesiger's account of his travels in Oman and appears at the same time as the folding map which illustrates these travels. *T. A. Brocklebank*, now a House Master at Eton College, was a member of the Mount Everest expedition of 1933. *M. Aurousseau*, Secretary of the Permanent Committee on Geographical Names, is a graduate of the University of Sydney where he studied under the late Sir Edgeworth David.

INSTITUTE OF BRITISH GEOGRAPHERS

The Institute of British Geographers, which now has a membership of over 250, held another very successful residential conference in Oxford from 5–8 January 1951. More than 160 members, drawn from all universities in Britain, attended as well as associates from seven foreign countries.

At the annual general meeting held in Jesus College on January 6, Professor A. G. Ogilvie, O.B.E., was elected President in succession to Professor S. W. Wooldridge, and Mr. Arthur E. Smailes of University College, London, Secretary-Treasurer. He succeeds Professor R. Ogilvie Buchanan, whose great services for the Institute ever since its inception, and especially in organizing its revival and vigorous expansion since the war, were warmly acknowledged.

The papers delivered by members and discussed during the conference were representative of a wide range of the research that is being carried out by British geographers. Medieval settlement patterns in sample areas of North Wales were analysed by Mr. G. R. J. Jones, and the social differentiation in the American city of Utica was discussed by Dr. Emrys Jones. Mr. W. K. Turner described the development of Dundee as a textile centre, Mr. E. M. Rawstron examined the distribution of steam-driven power stations in Great Britain with special reference to the location factors involved, and Dr. R. J. Harrison-Church described the inland Niger delta irrigation works. Crop-weather relationships as a basis for forecasting the yields of spring-wheat in America were discussed by Miss E. M. Frisby, and crop distributions in south-west Lancashire were related to soil conditions by Mr. J. A. Taylor. Three new world climatic

maps displayed and explained by Professor A. A. Miller aroused much interest in connection with vegetation correlations. The field of geomorphological research was represented by papers on slope development in South Wales by Mr. R. Savigear and in the Jurassic belt by Mr. G. Dury. Mr. S. W. E. Vince's analysis of the occupation structure and distribution of the rural population in England and Wales drew conclusions of considerable practical importance for planning policies.

A lively discussion was provoked by an evening discourse in which Mr. A. F. Martin examined with remarkable lucidity some metaphysical problems which confront geographers and paid special attention to the problem of causation.

The conference was greatly indebted to the staff of the School of Geography at Oxford for the organization and conduct of a variety of interesting excursions in and around Oxford.

With such a high proportion of the membership attending, the numerous opportunities for informal contacts which are provided by a residential conference are contributing to make the January conference of the Institute a great occasion in the calendar of academic geographers. The Council has accepted an invitation from the University College of Wales to hold the next of these meetings in Aberystwyth. A. E. S.

INTERNATIONAL GEOGRAPHICAL CONGRESS

The seventeenth International Geographical Congress is to be held in Washington, D.C., in 1952, and a special committee under the chairmanship of Dr. Charles F. Kohn, a member of the United States National Committee for Geography (I.G.U.), has been established to give financial and other help for visiting geographers. It is planned that grants-in-aid for a limited number of foreign delegates will be made available on their arrival in the United States and it is also hoped to arrange lecture engagements for delegates. Geographers who wish to attend the Congress but who will need assistance are invited to write to Dr. Kohn, Department of Geography, Northwestern University, Evanston, Illinois, U.S.A.

THE INTERNATIONAL UNION OF GEODESY AND GEOPHYSICS

The ninth General Assembly of the International Union of Geodesy and Geophysics will be held at Brussels from 21 August to 1 September 1951. Fellows proposing to attend the Assembly should inform the Assistant Secretary of the Royal Society, Burlington House, London, W.1., as soon as possible. Private individuals will be welcomed provided that their applications are endorsed by the British National Committee for Geodesy and Geophysics.

Professor F. A. Vening Meinesz will be President of the Union; Professor S. Chapman and Dr. L. H. Adams, Vice-Presidents; and the General Secretary is Dr. J. M. Stagg. The presidents of sections are W. D. Lambert (Geodesy), Dr. R. Stoneley (Seismology), Dr J. Bjerknes (Meteorology), Professor S. Chapman (Terrestrial Magnetism and Electricity), Professor H. U. Sverdrup (Oceanography), Professor Escher (Vulcanology), and Merrill Bernard (Scientific Hydrology). Dr. H. Wilson Ahlmann is Chairman of the Commission on Snow and Ice, with Mr. J. M. Wordie as Vice-President and Mr. P. D. Baird as Secretary.

THE SIDNEY GILCHRIST THOMAS CENTENARY IN LUXEMBOURG

The centenary of the birth of Sidney Gilchrist Thomas on 16 April 1850 was commemorated particularly in those countries where the steel industry of the 'eighties benefited directly from the dephosphorizing or "basic" process,

devised by this English scientist and his cousin Percy Gilchrist. Nowhere was the occasion given greater prominence or were the tributes rendered to the memory of the inventor more appreciative than in Luxembourg. This was partly because the Grand Duchy was the first country in which it was decided to introduce the new process and partly because its adoption provided the basis for Luxembourg's modern economy through which, except for minor fluctuations, continuous prosperity has been enjoyed to this day.[1]

It was Norbert Metz, director of the Metz Iron Co. of Eich near Luxembourg, who was the first of the large producers to grasp the implications of Thomas's later experiments. Immediately following the successful demonstration of the basic process at Eston near Middlesbrough on 4 April 1879, he sent two representatives to England to obtain a licence for developing the method at his works. On the vessel in which they made the passage, these men (one of whom was Metz's son) encountered German representatives bent on a similar mission. On April 21, only seventeen days after the demonstration, a licence was granted to the Luxemburgers who forestalled both the Germans and the French.[2] Ironmasters from France and Germany however soon entered into agreements with Thomas, notably Schneider at Le Creusot and de Wendel at Joeuf (Lorraine).

From 1879 onwards the rebuilding of blast furnaces and the erection of Thomas converters was carried on in the Grand Duchy at an increasing rate. This resulted in a re-location of the industry, for the new plants, unlike the old which were distributed over the centre of the country in relation to sources of alluvial iron, were sited in the Minette district of the south. Through the Englishman's invention, the low-grade bedded ironstone suddenly acquired an entirely new significance. So far only one large blast furnace unit—that at Esch (1872)—had been erected on the Luxembourg Minette field. Work on a new plant was begun in 1882 at Dudelange and on 18 March 1886 the first basic-steel or Thomas steel as it is still called on the Continent, was produced. Other works followed in the same district, at Differdange in 1900, at Rodange in 1908, at Belval in 1912 and at Esch (a second works) in 1913. To the firms in Luxembourg and Lorraine in particular there is no doubt that, in solving the problem of dephosphorization, Thomas's contribution to steel technology ranked equal in importance to Bessemer's advance in pig-iron production.[3] Steel output in the Grand Duchy rose from 20,654 tons in 1886 to nearly 100,000 tons by 1890 and to a million tons by 1912. Having almost fully recovered from a period of dislocation at the end of the second world war, the output in 1948 reached 2,453,000 tons, about 98 per cent. being made in Thomas converters.[4]

The transference of the chief metallurgical interests to the south resulted in substantial changes in the growth and distribution of population in the Grand Duchy. Between 1880 and 1930 the total population increased from 205,000 to 300,000, due largely to a decline in emigration consequent upon a marked rise in prosperity and to the encouragement of immigrant labour for the iron and steel industry. The increase was naturally most striking in the south. Whereas in the canton of Mersch in central Luxembourg, where most of the older ironworks were situated, the population declined between 1880 and 1930 from 14,500 to 12,700, that of the canton of Esch embracing the Minette district

[1] See *Luxemburger Wort*, 15, 17 and 22 April 1950.

[2] P. J. Muller, 'Tatsachen aus der Geschichte des Luxemburger Landes,' 1939, p. 241.

[3] *Iron and Coal Trades Review*, 160 (1950) 856.

[4] 'Statistiques économiques luxembourgeoises,' 1949.

rose from 20,000 to 105,000. During the same period, the town of Esch itself grew from a small centre of 3000 inhabitants to one of nearly 30,000, ranking as the leading industrial centre and the second town of the country. Similarly, with the commercial and industrial expansion resulting from the rise in iron and steel production, the population of the capital, only 12 miles from Esch, rose from 25,000 to 55,000.

In another quite different respect Luxembourg, more perhaps than other countries, has cause to acknowledge Thomas as a primary agent in shaping its economy. As Sir Charles Goodeve points out in his recent appreciation of Thomas,[1] the inventor was much exercised with the problem of making available to agriculture the quantities of phosphate contained in the phosphorus slag drawn from the basic converter. Though he did not live to achieve success in this direction, his efforts were brought to fruition in Germany not long afterwards and phosphate fertilizer from Thomas slag became a regular by-product of "basic" steel works. In Luxembourg, the benefit to agriculture was of revolutionary significance. The slaty and schistose soils of the Ardenne, deficient in both lime and phosphates, were soon made fit for at least moderate yields of oats, potatoes and fodder grasses, with dairy cattle, principally Friesian, replacing poor grade sheep. Even in the so-called *Bon Pays* where the Keuper Marl, Lias (Luxembourg) Sandstone and Lias Clay soils lacked the same constituents though to a less degree, the yields of all crops were substantially improved and, above all, the number and quality of livestock and milk output greatly increased.[2] Thus a revival in agriculture which found an expanding market in the industrial population brought a new prosperity to the rural areas.

Finally, while it is true that the fuel consumption per ton of basic (Thomas) steel is much greater than that for open hearth steel, the energy made available from coke-oven and blast furnace gases affords considerable compensation. In the Grand Duchy as elsewhere the use of these gases for electricity generation has been the means of providing a supply of industrial and domestic power at comparatively low cost. Being a very small country, transmission from the steel works over the entire territory was eventually achieved, often to isolated hamlets and farmsteads, though an integrated national scheme for distribution was not effected until 1927.

For all these reasons the centenary was regarded as an important public occasion in the Grand Duchy. In addition to formal meetings and conferences in Luxembourg, a bronze memorial tablet was unveiled at the town hall in Esch, bearing the inscription:

"1850–1950. À S. G. THOMAS Artisan de l'essor du Bassin Minier
La ville d'Esch-Alzette reconnaissante 16.4.50."

This tribute is symbolic of a far wider application of Thomas's contribution to metallurgy. For soon after his invention the basic process was extended to open-hearth furnaces and became the principal method of steel production in Britain and the United States. To-day about nine-tenths of the world's output is made in basic-lined furnaces or converters. K. C. EDWARDS

HEDGES AS FIELD BOUNDARIES IN GERMANY

Geographers in Great Britain have given little attention to hedges as a feature of landscape except to note their general distribution. German geographers however have discussed the subject at length. A study made by Jessen before

[1] *Engineering*, 169 (1950) 421.
[2] J. P. Zanen, 'Allerhand aus eiser Landwirtschaft an de letzten honnert Jor.' Luxembourg, 1939.

the war was summarized in the *Journal* (93 (1939) 371) and this note summarizes some of the more recent work.

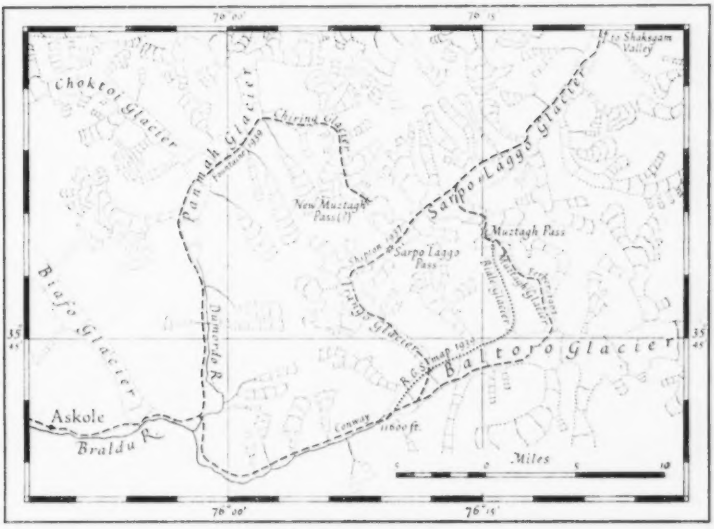
In "Die Heckenlandschaft," *Potsdamer Vorträge*. 8 (1944), Alwin Seifert considers the dangers to fertility on unfenced land in Northern Germany such as the Magdeburger Börde. He supports those who before the war wished to reduce the great estates with their large fields, minimal grassland and artificial fertilizers; in medieval Central Europe fertility was conserved by planting trees and thorns on every patch of bare ground. He emphasizes that on open land the wind moves top-soil, humus particles, CO_2 and the planted seed. Hedges are suited to oak-beech country, they yield the natural leaf-mould of the deciduous forest and, not being impenetrable, they form an ideal wind-break without producing dipping whirls. Hedges encourage an even spread of snow over the seeds and greatly increase the deposit of dew. In 1936 hedges were placed under national protection and, during the war, measures were afoot to extend their distribution. This article also treats in detail Soviet attempts to plant tree wind-breaks in the Ukraine.

Since the war much has been written about hedges, and two complementary studies bring out the main points: "Die Schleswig-Holsteinische Knicklandschaft," by G. Marquardt, *Schriften des geographischen Instituts der Universität Kiel*, 13, Heft 3 (1950), which cites most of the relevant references; and "Feldheckenstudien in Westmecklenburg," by H. Lautensach, *Petermanns Mitteilungen*, 2, 70–81 (1950), which is dedicated to Robert Gradmann. Marquardt is preoccupied with the statistics of the hedge. In Schleswig-Holstein its distribution is very variable, coinciding with the best morainic land of the east and the land of medium peasant holdings. It is more limited on the big estates and vanishes on the *Geest* of the west and in the marsh. Marquardt agrees with Jessen over the origins of the hedge; but he distinguishes between the oak-beech type on the eastern hilly moraines where the soil is good, and the oak-birch type on *Sandr* where infertile humus overlies an acid soil. The eighteenth-century enclosures led to an increase in the quantity of winter fodder, and hence in the numbers of cattle; these in turn produced more manure, making possible the elimination of fallow and an increase in ploughland. As the rights of common disappeared hedges were enforced by law and became an alternative and important source of timber. In Schleswig-Holstein to-day they cover 23,500 ha., and yield timber equivalent to 20,000 ha. of forest. Hedges produce fruit and food for bees, they check the spread of weeds, and encourage the birds that feed on insects, mice and other pests of the grain-field. Against this is the fact that hedges cover about 3 per cent. of the area and freeze the shape of an agricultural unit, while the full use of machines and the drying of crops may be hindered. On balance however hedges are beneficial; they reduce the force of the wind, lead to an increase in grain yield of about 20 per cent., and increase the deposit of dew in critical seasons. It is estimated that with hedges 200–300 metres apart the wind may be reduced by 25 per cent., and in an area with a rainfall of 600–700 mm., evaporation may be reduced to an extent equivalent to a 200–250 mm. increase in rainfall.

Lautensach's investigation in West Mecklenburg agrees closely with that of Marquardt. There was much Bauernlegen (seizure of peasant land by landlords) during the nineteenth century, the big estates introduced extensive grain agriculture, and the hedges have been declining. He gives a more detailed analysis of hedge types and emphasizes again the tendency for seeds to blow away in hedgeless land. He considers that hedges are best suited to areas where grain and grass enter into rotation, but until recently the tendency in Mecklenburg has been against them. D. J. D.

THE MUZTAGH PASS ON THE SOCIETY'S KARAKORAM MAP

It has been pointed out by Mr. A. C. Ferber that the route up to the Muztagh pass shown on the 1/750,000 scale Karakoram Map published by the Society in 1939 is incorrect. Commencing from the spot height 11,600 marked at the head of the Braldu valley the route shown on the map strikes directly up the "snout" of the Baltoro glacier bearing slightly to the north until it joins the northern or right flank of the glacier near the "L" of Baltoro. Thereafter it follows along the foot of the north wall for a short distance until it turns up the Biale glacier, a small tributary glacier descending from the north and named on Conway's and Ferber's map "Piale Luma." The route shown then climbs obliquely up the western face of a very steep ridge which culminates in a peak of 22,080 feet referred to as "Neptune" in the account of Ferber's expedition.[1]



The Muztagh pass

From a study of Conway's map, later embellished by Ferber, and from the latter's photographs, it is obvious that any route up the Biale glacier would be doomed to failure. The "traditional" Muztagh pass, first crossed by Younghusband in 1887 on his remarkable journey from Peking, lies immediately to the north of "Neptune Pk." at the head of the Muztagh glacier which joins the Baltoro some 2 miles east of the Biale glacier. The route followed by Ferber and his companion E. Honigmann in 1903 follows closely the southern flank of the Baltoro until it reaches a point south of the first "O" of Baltoro on the Society's map and then crosses to the foot of the Muztagh glacier, whence it climbs more or less directly up the centre of the Muztagh glacier until it reaches the foot of the ice-fall below the pass. Beyond this point Ferber's party was forced to make a difficult ascent up the west flank of the ice-fall beside the rock cliffs; this proved too difficult for their porters. Ferber remarks that formerly there

[1] "An exploration of the Muztagh pass in the Karakoram Himalayas," *Geogr. J.* 30 (1907) 630–43.

may have been much more snow which would account for the pass having been used as a caravan route in ancient times. The Duke of Spoleto's expedition which ascended to the pass in 1929 did however succeed in finding a way up the ice-fall for laden porters, though it took the party several days to negotiate a route.

It is interesting to note that two other passes across this sector of the Asiatic Watershed have since been discovered by later expeditions which throw some doubt on the authenticity of the so-called "Muztagh pass" as the traditional caravan route. Shipton in his book 'Blank on the map,' describing the Shaksgam Expedition of 1937, says, ". . . the pass we had just crossed for the first time, now to be called the Sarpo Laggo pass,[1] would have been a much easier route than the Muztagh pass with its difficult precipice, though the latter is supposed to have been used by the ancient travellers." In 1939 the late Dr. E. C. Fountaine, a member of Shipton's second Karakoram Expedition, went up the Chiring glacier, a tributary of the Panmah, and ascended without difficulty to a col overlooking a branch of the Upper Sarpo Laggo glacier. Although time did not permit him to cross over, he reported that the descent down to the Sarpo Laggo appeared to be no more difficult than the ascent from the west. The pass he was on (the long-sought "New Muztagh pass") would appear to be the easiest yet discovered linking Askole on the southern side of the watershed with the Shaksgam valley on the north. P. G. M.

IRRIGATION AND POWER PROJECTS IN THE DNIEPER VALLEY

Details were published recently of a new Russian project for utilizing the waters of the lower Dnieper to assist agriculture and industry in the Crimea and Southern Ukraine. The use of the lower Dnieper for irrigation has been hindered by the fact that the river flows about 200 feet below the level of the land that needs irrigation. But with the completion of the Lenin hydro-electric station and dam the water level will be above much of the surrounding land. It is proposed that water which is surplus to the needs of the Lenin power station shall be led by canal from Zaporozhye, just above the dam, into a large storage reservoir on the Molochnaya river. A new dam is to be built north of Melitopol, and the storage reservoir will have a capacity of 8000 million cubic yards.

From the Molochnaya river reservoir the "South Ukrainian Canal " will run to Askaniya-Nova. Its continuation, the "North Crimean Canal" will run on through the North Crimean steppes to Kerch. These two canals will have a total length of 350 miles. Along them a number of smaller reservoirs will be constructed, while 200 miles of lateral canal will help distribute the water. The whole system aims at irrigating $1\frac{3}{4}$ million acres. It is also proposed to construct a dam and 250,000 kilowatt hydro-electric station near Kakhovka on the Dnieper. The reservoir behind this dam will feed another irrigation canal, and part of the electricity generated will operate giant pumps for irrigating nearly 2 million acres of high-level land on both banks of the Dnieper, but particularly on the right bank.

The southern part of Ukraine and northern Crimea have a deep fertile black soil, but drought is common. The planting of shelter-belts will help to fix the wind-blown South Dnieper sands.

A NEW MAP OF MONASTIC BRITAIN

The latest "national period map" published by the Ordnance Survey essays a difficult task—to show the development of monastic settlement in Britain

[1] At the head of Trango glacier.

through the period of its greatest activity, that is from the Norman conquest to the dissolution of greater monasteries in 1540. Published in two sheets, with an introduction and index (price for each sheet 2*s* 6*d*, or 7*s* 6*d* mounted), the base is the 10-mile to 1-inch map printed in grey, with light buff layer tinting at 100, 300 and 500 metres. On this is overprinted in black the distribution of the houses of monks, cannons and nuns, and the lesser religious establishments. By a neat system of symbols, the houses of the principal orders are distinguished and those which existed until 1500 are specially emphasized. There is a slight discrepancy between the map and the text as the latter gives 1540 as the terminus, but this probably has little effect on the number of houses. The symbols are also graded in accordance with the importance of the establishments. Diocesan boundaries and peculiar jurisdictions are drawn. The lists have been compiled by Mr. R. N. Hadcock as the result of many years' work and he has also written the introductions.

The map gives a general picture of the areas in which medieval monasticism was most active and does not portray the position at any particular moment. The work of the Cistercians in Yorkshire, where they did much to improve the countryside, is very evident. It would form a good exercise in historical geography to "describe and account for" the distribution as shown on the map. No doubt additions could be made to the number of granges and other minor centres and the Director-General hopes that the results of further research, stimulated by this publication, will be incorporated in a second edition. Historians and geographers will be glad to know that this important series is to be continued. G. R. C.

A NEW HISTORICAL ATLAS OF FINLAND

The Atlas of Finnish History (*Suomen historian kartasto:* Helsinki, 1949) edited by Eino Jutikkala, Professor of Economic History in the University of Helsinki—is a welcome addition to the limited material available in English on Finland. Most of Professor Jutikkala's publications on the economic history of Finland are in Finnish and are necessarily closed books to Britain. The atlas summarizes visually much of Finland's history and although Swedish is the second tongue in this bilingual country, English has been chosen as the second language for the captions. It is a pity for the inquisitive that the notes on cartographic and source material which form an appendix to the atlas are not also translated. This deficiency is in part met by a paper on the atlas by the author, "The economic development of Finland shown in maps," *Proceedings of the Finnish Academy of Science and Letters*, Helsinki (1950) 159–166, which has been reprinted in English.

The seventy-four maps and diagrams deal principally with economic and social themes. They embrace a group to show the development and distribution of settlement from the prehistoric period to the present day, a series on the evolution of the administrative, ecclesiastical, judicial and educational units of Finland and a group to illustrate the intensification of cultivation and industrialization. Examples selected from the rich collection of land redistribution maps housed in the Finnish Land Survey Office (*Maanmittaushallitus*) show the influence of the "enclosure" movement (*isojako*) and seven historical maps of leading cities are redrawn from the originals. Different maps will appeal to different readers. For those who cultivate the undefined borderlands between economic history and historical geography there is Number 48, which portrays Finland's rural economic conditions in the 1830's and is based on a rural census conducted through parish priests by C. C. Böcker, a secretary of the Agricultural Society of Finland. The Böcker collection, housed in the State

Archives in Helsinki, still awaits cartographic exploitation. Finland as a political marchland is represented by ten studies of invasion tracks, by an analysis of the troop recruiting districts organized in former times in response to the eastern challenge, and by an outline of the baronies created to buttress the Duchy in the Swedish era.

The atlas is a new departure both for Finnish history and for the publishers. Its compilers do not claim to be either experienced cartographers or geographers. Thus, whether there is agreement or disagreement over cartographical representation (as for example in Number 57, the map of internal population migration) both method and map have a valuable comparative significance. Certain maps suffer from crowding of detail, for example Number 13; but Finland's network of waterways must perhaps be blamed for this. The geographer may disapprove of presenting the country in two parts in order to make it fit the printed page, for example Numbers 12 and 15, especially when the two parts are not reproduced on the same scale and there is nothing to indicate this fact. Most criticisms will be overlooked however in admiration of the author's generous presentation of a variety of new detail from the past of a little-known country. W. R. M.

A GAZETTEER FOR BASUTOLAND

A handsome foolscap volume just published at Paarl, C.P., South Africa, entitled 'Gazetteer for Basutoland' (346 pages), contains also a list of names in territories bordering on Basutoland which are of interest in the history of the Basuto (66 pp.), a list of farm names and *noms de lieux-dits* on the immediate boundary of Basutoland (11 pp.) and about eighty blank leaves for notes. The names are given in the Roman alphabet established in native use in Basutoland, which was stabilized by the Conference on Sesuto Orthography of 1906. The work is the result of about ten thousand miles of reconnaissance on the part of Captain R. S. Webb, who has been engaged on the collection and checking of Basuto names for a number of years. The book was privately printed at Paarl by A. H. Fisher and Sons, in an edition of one hundred copies none of which is for sale. Captain Webb has kindly deposited a copy in the Library of the Society and another in that of the P.C.G.N., but the main distribution of the book is to be among the Basuto. Merely as an example of book-production this volume attracts attention. The choice of type and materials was discriminating, and the printing is admirably clear. So high a standard is unusual in the productions of small country centres. As a guide to the geographical names of Basutoland the work is unrivalled, and will be the standard for a long time to come.

M. A.

NEW TABLES FOR THE NATIONAL GRID

The publication of 'Projection tables for the transverse Mercator projection of Great Britain' by the Ordnance Survey (H.M. Stationery Office, 1950, price 4*s*) and an accompanying pamphlet of 32 pages (price 1*s*) provides surveyors with all they require to adjust local surveys to the National Grid. The tables, which have been arranged for convenient use with computing machines, are very legibly reproduced from typescript; values are tabulated at intervals of one minute of latitude from 49° N. to 61° N. and it is stated that simple interpolation will not lead to errors of position exceeding 0·1 metre or 0·01 seconds of arc. They provide for the conversion of geographical to grid coordinates and *vice versa*, for the computation of azimuth corrections from either set of data and for the evaluation of the scale factor at any point.

The pamphlet, 'Constants, formulae and methods used in transverse Mercator projection,' fully explains the use of the tables and is illustrated by a

complete set of examples of the computations. The formulae on which the tabulated quantities are based are given but the reader is referred to other works for their derivation. The first eleven pages are however of more general interest, for they describe briefly the original triangulation of the British Isles and its adjustment, and the retriangulation which is still in progress. The old 6-inch and 1 : 2500 plans were drawn on the Cassini projection with no fewer than thirty-nine different county meridians and led to inconveniently large discrepancies at county boundaries—often the sites of modern development. The reasons for changing to a single projection for the whole country and the choice of the transverse Mercator are discussed, the properties of the projection clearly explained and its limitations stated. The true scale of the 1 : 2500 plans will be in fact about 1 : 2501 along the central meridian (longitude 2° W.) and 1 : 2499 at the east and west coasts. The angular distortion in a triangle with 4-mile sides will not exceed 7 seconds of arc at most and can readily be calculated from the tables. F. G.

SCHOLARSHIPS ABROAD 1951–52

Scholarships for the academic year 1951–52 are being offered to British students by governments and universities in a number of foreign countries. Closing dates for applications from candidates vary for each country and range between 7 March and 1 June 1951. Information and application forms are obtainable from any office of the British Council in the United Kingdom.

OBITUARY

BERTRAM SIDNEY THOMAS, C.M.G., O.B.E.

Bertram Thomas, a Gold Medallist of the Society and the first European to cross the Empty Quarter of Arabia, died on 27 December 1950.

I cannot claim to have known Bertram Thomas for I only met him twice, in Cairo during the war, and only for a few minutes. I have however travelled widely in Southern Arabia during the past five years with the Rashid, some of whom accompanied him on his great journey. I have known Salih bin Kalut and others of his companions and from them I have heard many tales of the first "Nasrani" to come among them.

Badu notice everything and forget nothing. Garrulous by nature they reminisce endlessly, whiling away with their chatter the long marching hours and talking late into the night round their camp fires. Their life is at all times desperately hard and they themselves are merciless critics of those who fall short of them in patience, good humour, generosity, loyalty and courage. Living in the seclusion of the desert they have no knowledge of the outside world nor of a way of life different from their own. They make no allowance for the stranger. He who lives with the Badu must accept Badu conventions and conform to Badu standards. Only those who have journeyed with them can appreciate the strain of such a life. These tribesmen are accustomed since birth to the physical hardships of their land, to drink the scanty bitter water of the sands, to eat gritty unleavened bread, to endure the maddening irritation of driven sand, bitter cold, heat and blinding glare in a land without shade or cloud. But more wearing still for the European is the nervous tension. I know how hard it is to live crowded together with people of another faith, speech and

culture in the solitude of the desert, how easy it is to be provoked to senseless wrath by their importunities and improvidence. Bertram Thomas had reason to be impatient. He had lost precious months of the cold weather waiting in Dhufar before Salih bin Kalut and his Rashid arrived. The previous year he had reached Mughshin and there upon the threshold of the sands, had been thwarted by the timidity of his Bait Kathir companions. Thomas was far from being a Badui by nature and yet I have never heard a Rashidi speak a disparaging word about him. I have heard them criticize him for tiring their camels with the heavy foreign saddle on which he rode, or comment on his fondness for sleeping apart from his companions; but these were idiosyncrasies which they accepted even if they never understood them, things which they now recall with a smile. He was the first European to come amongst them and he won their respect by his good nature, generosity and determination. They remember him to-day as a good travelling companion. I who came amongst them twenty-two years later, was welcomed by these exclusive tribesmen because I was of the same tribe as Thomas.

In 1930 the Empty Quarter was the last large area of the world which still remained unknown. The crossing of this desert offered the final and greatest prize of Arabian exploration. Many famous Arabian travellers had dreamed of this achievement but the realization of the dream was reserved for Bertram Thomas and St. John Philby. As the names of Amundsen and Scott will always be associated with the attainment of the South Pole so will the names of Thomas and Philby be remembered in connection with the crossing of the Empty Quarter.

T. E. Lawrence in a letter to Lord Trenchard, then Marshal of the R.A.F., suggested in 1929 that either the R100 or the R101 should be diverted on its trial trip to pass over the Empty Quarter and wrote "To go over the empty quarter will also be an enormous advertisement to them. It will mark an era in exploration. . . . Nothing but an airship can do it, and I want it to be one of ours which gets the plum." This shows how formidable an undertaking Thomas's journey in 1930 appeared to his contemporaries. Recent exploration has shown that this desert is not as impassable as was once supposed and that a European, who has carefully selected his companions from the sand-dwelling tribes, can penetrate anywhere into its fastnesses. Thomas's object was to cross the Empty Quarter, an undertaking which no European had yet achieved, and naturally he crossed it by the easiest way, where the sand dunes were small and the wells, known to his Rashid guides, were frequent. To-day this route would offer no real difficulty, because the traveller would know what lay ahead of him. To minimize Thomas's achievement by saying that his route proved easy would be as unjustifiable as to depreciate the first ascent of a great mountain because it was climbed by the easiest face. Philby's route was far more difficult and the 400 miles between wells which he covered across the western sands at the end of his journey will always be an epic of desert travel. Before he started from Riyadh he heard that Thomas had already crossed from Dhufar to Qatar. Bitterly disappointed he yet continued undeterred with his plans and carried out a journey which the discerning will regard as the greater of the two. Thomas and Philby had both determined to cross the Empty Quarter many years before they succeeded. Thomas had prepared himself by making exploratory journeys from Muscat along the coast to Dhufar and from Dhufar to Mughshin, while Philby had been awarded the Founders Medal of this Society in 1920 for his explorations in the Najd. Philby had certain advantages which were denied to Thomas. Once he had obtained Ibn Saud's permission to undertake this journey, and it was the king's delay in granting him this permission which lost

him the race, he had behind him Ibn Saud's far-reaching authority. As a Muslim with the backing of the widely feared bin Jaluwi, Governor of the Hassa, he could pass safely through the territory of the powerful Murra, whereas Thomas ran his greatest risk from this tribe, many of whom were then extremely fanatical as a result of Ikhwan teaching. Thomas had to make all his preparations himself. The Sultan of Muscat and his "wali" in Dhufar were friendly but their effective authority did not even extend as far as the Qarra mountains, four miles away across the plain from the fort at Salala. Thomas had to discover from experience which of the tribes could be of use to him and contact them himself. As a Christian he was at first suspected and disliked. The measure of his achievement is that he won the confidence of these proud and difficult tribesmen, and with no authority behind him, persuaded them by patience and fair dealing to take him across the Empty Quarter.

WILFRED THESIGER

EUGENE CHOLNOKY

We regret to record the death, in July 1950 at the age of seventy-nine, of Professor Eugene Cholnoky (Professor Dr. Cholnoky Jenö). He was one of those elected to the Honorary Membership of our Society on the occasion of the centenary celebrations in 1930 and we have received the following appreciation from Dr. Albert Pésci, Secretary-General of the Hungarian Geographical Society.

From his youth up Eugene Cholnoky played a notable part in the study of geography in Hungary. Between 1894 and 1925 he was engaged in the scientific survey of lake Balaton of which he took charge on the death of his former teacher, Ludwig von Lóczy, and in 1896–98 he undertook a journey of exploration in Manchuria and China. His most important achievement was the establishment in 1902 of the laws which govern the movement of incoherent sands. In 1916 he published studies on *karst* topography; his work on the changes in the course of the Tisza led in 1907 to investigations on the great plain of Hungary and, four years later, he founded the Commission d'Alföld over which he presided until his death.

In 1922 he was engaged in an attempt to establish the foundations of human geography. Of his published works, 'Géographie générale,' published in 1923 is one of the best books in that field and his 'Morphologie,' published in 1926, is distinguished alike by its scientific precision and its felicity of style; his 'Géographie de Hongrie' is a model for physiographical monographs.

Apart from his own scientific work, Cholnoky was a well-known exponent of popular science and an excellent draughtsman, painter, lecturer and teacher. Appointed professor at the University of Kolozsvár in 1905 and at the University of Budapest from 1921 to 1940, he collected around him a group of Hungarian geographers who will carry on his work. As Secretary-General of the Hungarian Geographical Society from 1906, and as its President from 1915 to 1945, he guided the scientific approach to the study of his native land. His name and his achievements are known and honoured wherever the study of geography is cultivated.

CORRESPONDENCE

THE WHITE NILE FLOOD PLAIN

Since the publication of my paper on the White Nile flood plain (*Geogr. J.* 114 (1949) 173) an error in one of the cross-sections has come to light and this affects the results I quoted; the cross-section concerned was no. 4 (80 kilometres from Malakal) and it has been found that there was an error of 1 metre in the levels given on the drawing from which I worked. This section is depicted at the top of Fig. 2 in my paper and the datum line drawn there should therefore be raised by 1 metre relative to the actual cross-section; the value of the datum (380·7 metres) remains unchanged.

The effect of the error is to make all the widths derived from this cross-section much too small. In my Fig. 4 its idealized bank profile is one of the steepest, but in fact it approximates very closely to the mean for the Malakal–Melut reach. The effect of the error on the mean flood-plain widths for that reach (as shown in my Fig. 6 a) is to make them too small by about 6 per cent. at all rises of the river. Since the flood-plain areas between Malakal and Melut are only about one third of the totals from Malakal to Jebelein, the effect on the totals shown in Fig. 7 is of course correspondingly reduced and is about 2 per cent.

In the footnote to page 188 reference was made to a comparison between the flood-plain widths between Malakal and Melut as predicted by the mean idealized bank profile and as measured from the new air survey maps. When the error of 6 per cent. in the mean flood-plain width for this reach is allowed for the difference between the predicted and "observed" widths is reduced from 11 per cent. to under 6 per cent., so that the agreement is really remarkably close. The discovery of the error does not therefore detract from the results quoted in my paper but shows rather that the uniformity of the mean idealized bank profile on the White Nile is even greater than had been supposed.

J. W. WRIGHT

6 *November* 1950.

ADDITIONS TO THE LIBRARY AND MAP ROOM

EUROPE

DAS ALTER DER SCHWARZERDE UND DER STEPPEN MITTEL- UND OSTEUROPAS

By H. Wilhelmy. (*Erdkunde*, 4 (1950) 5–34; maps)

THE UPLAND PLAINS OF BRITAIN: their origin and geographical significance

By S. W. Wooldridge. (*Adv. of Science*, 7 (1950) 162–75)

Pres. Address to Section E at Birmingham, 1950.

DOMESDAY WOODLAND

By H. C. Darby. (Repr. fr. *Economic Hist. Rev.*, *2nd ser.*, 3 (1950) 21–43; sketch-maps)

SOME FEATURES IN THE STRUCTURE AND GEOMORPHOLOGY OF THE COUNTRY AROUND FERNHURST, SUSSEX

By S. W. Wooldridge. (*Proc. Geologists' Assocn.*, 61 (1950) 165–90; illustrations and diagrams)

OFF TO THE DALES: walking by the Aire, Wharfe, Ure and Swale

By Jessica Lofthouse. $8\frac{1}{2} \times 5\frac{1}{2}$. 314 pp. Illustrations. *London: Robert Hale*, 1950, *15s*

SCOTTISH COAL

By R. A. Moore. (*Scottish Geogr. Mag.*, 66 (1950) 26–36; illustrations and sketch-maps)

LEINSTER, MUNSTER AND CONNAUGHT

By Frank O'Connor. (*The County Books series.*) $8\frac{1}{2} \times 5\frac{1}{2}$. 296 pp. Map and illustrations. *London: Robert Hale*, 1950. *15s*

An entertaining commentary on men and places, with many anecdotes and personal reminiscences. The illustrations, particularly of architectural subjects, are of much interest.

DIE QUARTÄRGESCHICHTE DES DONAUDELTAS

By Max Pfannenstiel. (*Bonner Geogr. Abhandlgn.*, 6 (1950) 86 pp.

EFFECTS OF BOUNDARY CHANGES IN THE SOUTH TYROL

By Guido G. Weigend. (*Geogr. Rev.*, 40 (1950) 364–75; sketch-maps and illustrations)

LAND OF LAKES

By H. McG. Bell. $8\frac{1}{2} \times 5\frac{1}{2}$. 246 pp. Illustrations. *London: Robert Hale*, 1950. *15s*

An account of Finland and its recent history. The author was Acting Consul-General.

FRENCH LIFE AND LANDSCAPE: I. Paris and the north

By Alfred Firth. $8\frac{1}{2} \times 5$. 132 pp. Illustrations. *London: Paul Elek*, 1950. *12s 6d*

A commentary on France and the French which replaces to some extent the conventional guide book, and is evidently the work of an enthusiast who knows the country at first hand.

PARIS (*The People's France*)

Ed. by A. H. Brodrick. $8 \times 5\frac{1}{2}$. xxii +478 pp. Plans and illustrations. *London: Hodder and Stoughton*, 1950. *20s*

A guide to Paris arranged by *arrondissements;* each section includes historical anecdotes, references to buildings which have now disappeared, comments on architectural style, and much miscellaneous information in a rambling, colloquial style.

LE PROBLÈME DE LA RESTAURATION DES LANDES DE GASCOGNE

By L. Papy. (*Cahiers d'outremer*, 3 (1950) 231–79; illustrations and maps)

DIE VERBREITUNG DER MITTELALTERLICHEN WÜSTUNGEN IN DEUTSCHLAND

By Heinz Pohlendt. (*Gottinger Geogr. Abhandlgn.*, 3 (1950) 86 pp.; sketch-maps)

An attempt to examine quantitatively the intensity of forest clearing, and the reasons for regional differences. The movement was strongest in Central Germany, particularly the Hesse-Thuringia area.

VERSUCHE KULTURLANDSCHAFTLICHER GLIEDERUNG AM BEISPIEL VON WÜRTTEMBERG

By F. Huttenlocher. (*Forschgn. z. deut. Landeskunde*, 47 (1949) 48 pp.; maps)

DIE DILUVIALE EROSION UND AKKUMULATION: Erkenntnisse aus Untersuchungen über die Talbildung im Alpenvorland

By Ingo Schiefer. (*Forschgn. z. Deut. Landeskunde*, 49 (1950) 154 pp.; diagrams)

DIE DILUVIALEN TERRASSEN DES OBERHARZES UND SEINES VORLANDES: ein Beitrag zur Frage der Harzhebung

By J. Hövermann. (*Petermanns G. Mitt.*, 94 (1950) 121–30; map and profiles)

DIE KARTE VON PREUSSEN DES HEINRICH ZELL, 1542

By W. Horn. (*Erdkunde*, 4 (1950) 67–81)

WINTERS OF CONTENT AND OTHER DISCURSIONS ON MEDITERRANEAN ART AND TRAVEL

By Osbert Sitwell. $8\frac{1}{2} \times 5\frac{1}{2}$. 362 pp. Illustrations. *London: Gerald Duckworth*, 1950. 21*s*

Reprinted portions of earlier works by Sir Osbert Sitwell on Italian life and landscape, and of critical essays on painting and architecture.

LA VAL BLENIO: Caratteri e problemi di una valle del Ticino settentrionale

By C. Caflisch. (*Geogr. Helvetica*, 5 (1950) 137–49; illustrations)

LE VALLE PIÙ OCCIDENTALI DELLA LIGURIA

By M. R. Prete. (*Annali di ricerche geogr.* (*Genova*), No. 7 (1949) 13–41; illustrations and sketch-maps)

THE RECOVERY PROGRAM IN SICILY

By Diamond Jenness. (*Geogr. Rev.*, 40 (1950) 355–63; sketch-map and illustrations)

BUILDING ROCKS IN POLAND

By Marian Kamieński. (*Inst. Géol. de Pologne, Bull.* 57 (1949) 134 pp.; diagrams). [In Polish; English summary]

REGIONY KLIMATYCZNE POLSKI

By E. Romer. (*Trav. Soc. sc. de Wrocław, Ser. B*, 16 (1949) 26 pp.; maps)

DER KAMPF GEGEN DIE DÜRRE IN DER SOWJETUNION

By Erwin Buchholz. (Extr. fr. *Mitt. Bundesanstalt f. Forst-u. Holzwirtschaft, Hamburg, No.* 12, *Jan.* 1950. 38 pp.; sketch-maps)

ASIA

DEN 3. DANSKE CENTRALASIATISKE EKSPEDITION. (*Geogr. Tidsskr.*, 49 (1948–9) 5–20; map and illustrations)

A NOTE ON IRRIGATION IN CEYLON

By E. K. Cook. (*Geography*, 35 (1950) 75–85; sketch-maps)

PROEVE ENER PLANTENGEOGRAFIE VAN CELEBES

By H. J. Lam. (*Tijds. K. Nederl. Aardrijks. Gen.*, 67 (1950) 566–604; illustrations)

THE DAMODAR VALLEY—"VALLES OPIMA"

By William Kirk. (*Geogr. Rev.*, 40 (1950) 415–43; maps)

Account of a project for flood control, irrigation and development in Bihar and West Bengal.

THE DEVELOPMENT OF LANDFORMS, SOILS, AND LIFE IN THE NEIGHBOURHOOD OF JUBBULPORE AND BHERAGHAT, MADHYA PRADESH

By H. L. Chhibber. (*Bull. Nat. Geogr. Soc. India, Banares*, No. 14 (1950) 1–63; illustrations)

Prof. Chhibber studies the geomorphology of the area, and particularly the features produced by heavy weathering of granite and limestone formations, of which he has several striking photographs.

PAKISTAN PROBLEMS AND PROSPECTS

By V. S. Swaminathan. (*Middle East J.*, 4 (1950) 447–66)

BIRDJAND, EINE OSTPERSISCHE STADT

By G. Stratil-Sauer. (*Mitt. Geogr. Ges. Wien*, 92 (1950) 106–22; sketch-map)

UN VILLAGE DU LIBAN: EL MTAÏNE. NOTE DE GÉOGRAPHIE HUMAINE

By Maurice Fevret. (*Rev. de Géogr. de Lyon*, 25 (1950) 267–87; maps and illustrations)

KAILAS-MANASAROVA

By Swami Pranavananda. 10×6. xxiv +242 pp. Maps and illustrations. *Calcutta: S. P. League Ltd.*, 1949. 25*s*

The author has made many pilgrimages to the Himalaya and particularly to the area in S.W. Tibet described here. One section sets out the physical and human geography in general; another forms a route book.

AFRICA

LES VILLAGES INDIGÈNES D'ORAN

By René Emsalem. (*Rev. de Géogr. de Lyon*, 25 (1950) 289–99; sketch-map and *illustrations*)

THE SURVEY OF EGYPT, 1898–1948

Edited by G. W. Murray. (*Survey Dept. Paper*, 50 (1950) 94 pp.)

VILLES D'AFRIQUE OCCIDENTALE

By J. Dresch. (*Cahiers d'outremer*, 3 (1950) 200–30; illustrations and sketch-maps)

HISTOIRE DES POPULATIONS DU CERCLE DE DOSSO (NIGER)

By Jean Périé and Michel Sellier. (*Bull. Inst. franç. d'Afrique Noire*, 12 (1950) 1015–74; sketch-maps)

LES CONDITIONS DE VIE DES INDIGÈNES DE DOUALA

By J. Guilbot. (*Études Camerounaises*, 2 (1949) 179–239)

LE PORT D'ABIDJAN: le problème des debouchés maritimes de la Côte d'Ivoire. Sa solution lagunaire

By G. Rougerie. (*Bull. Inst. franç. d'Afrique Noire*, 12 (1950) 751–837; sketch-maps and illustrations)

ÉTUDE PÉDOLOGIQUE DU BASSIN FRANÇAIS DE LA BIA, CÔTE D'IVOIRE

By A. Laplante and G. Rougerie. (*Bull. Inst. franç. d'Afrique Noire*, 12 (1950) 883–904; sketch-maps and illustrations)

KIGEZI RESETTLEMENT

By J. W. Purseglove. (*Uganda Journ.*, 14 (1950) 139–52; illustrations)

Methods followed in a district of Uganda to resettle surplus population and to improve use of the land.

A GLIMPSE OF SOUTH AFRICA

By M. S. Taljaard. 10×7. 226 pp. Map, diagrams and illustrations. *Stellenbosch: University Publishers*, 1949. 32*s* 6*d*

The author, Professor of Geography at the University of Stellenbosch, sets out to explain the surface features of S. Africa and their relation to the underlying rock structure, in accounts of nine journeys. There are numerous diagrams and photographs.

DIE GEHEIMNISSE DES KUNENELAUFES IN SÜDANGOLA UND SÜDWESTAFRIKA

By W. Beetz. (*Erdkunde*, 4 (1950) 43–54; sketch-maps)

LA DÉCOUVERTE DES ILES MASCAREIGNES

By Georges de Visdelou-Guimbeau. 11½×9. xii+65 pp. Illustrations. *Mauritius, Port-Louis, priv. printed*, 1948

A careful study of the European discovery of the islands based upon the earliest charts which have survived.

NORTH AMERICA

CLIMATE AND ZONAL DIVISIONS OF THE BOREAL FOREST FORMATION IN EASTERN CANADA

By F. K. Hare. (*Geogr. Rev.*, 40 (1950) 615–35; diagrams and illustrations)

NATURAL LANDSCAPES OF THE UNITED STATES

By J. F. Macbridge. (*Chicago Nat. Hist. Mus., Pop. Ser., Botany*, 27 (1950) 48 pp., sketch-maps and illustrations)

PHYSICAL FEATURES OF THE COLORADO VALLEY

By J. W. Powell. (*Sc. Monthly*, 71 (1950) 147–54; illustrations)

A reprint of an important article which introduced new conceptions in geomorphology, first published in 1875.

PRIBILOF FUR SEALS

By G. C. L. Bertram. (*Arctic*, 3 (1950 75–85; illustrations)

THE AZTECS OF MEXICO: origin, rise and fall of the Aztec nation

By George C. Vaillant. (*Pelican Books*) 7×4½. 334 pp. *Harmondsworth: Penguin Books*, 1950. 2*s* 6*d*

This account by a leading authority was first published in 1945: brief references to later developments have been added.

THE ANATOMY OF ELEVEN TOWNS IN MICHOACÁN, MEXICO

By D. Stanislawski. (*Univ. of Texas, Latin-American Studies*, 10 (1950) 78 pp.; plans and illustrations)

VOLCANOES OF THE PARICUTIN REGION, MEXICO. By Howel Williams.

EROSION STUDIES AT PARICUTIN. By Kenneth Segerstrom.

(*U.S. Geol. Survey Bull.*, 965A and 965B (1950); 280 pp.; maps and illustrations)

SOUTH AMERICA

RIVIERVORMEN IN DE KUSTVLAKTE VAN SURINAME

By J. I. S. Zonneveld. (*Tijds. K. Nederl. Aardrijks. Gen.*, 67 (1950) 605–16; illustrations and diagrams)

A study of some remarkable meander forms as revealed by air photographs.

OBSERVAÇÕES GEOGRAFICAS NA AMAZONIA: Pt. I. Observações sobre a morfologia e os solos

By Pierre Gourou. (*Rev. Brasil. de Geogr.*, 11 (1949) 355–408; illustrations and maps)

EUROPEAN COLONIZATION IN SOUTHERN BRAZIL

By Leo Waibel. (*Geogr. Rev.*, 40 (1950) 529–47)

ZUR KLIMATOLOGIE UND BIOKLIMATOLOGIE DES ALTO-PARANÁ-GEBIETES IN SÜDAMERIKA

By Dr. H. Wilhelmy. (*Petermanns G. Mitt.*, 94 (1950) 130–39; map)

CONTRIBUIÇÃO AO ESTUDO DO CLIMA DO RIO GRANDE DO SUL

By F. Peixoto Machado. (*Inst. Brasileiro de Geogr.: Conselho nacional de geogr.*, 1950. 92 pp.; maps)

LA OLIVICULTURA EN LA REPUBLICA ARGENTINA

By M. I. Velasco. (*Bol. Estudios Geogr., Cuyo*, 1 (1949), No. 4, 11–27)

BOHEMIA JUNCTION

By A. F. Tschiffely. 9×5½. 322 pp. *London: Hodder and Stoughton*, 1950. 15*s*

Chapters from the author's reminiscences of his life in England and the Americas, and particularly of the unusual people he encountered.

AMONG THE GAUCHOS

By Hugo Backhouse. 8½×5¼. 208 pp. Illustrations. *London: Jarrolds*, 1950. 15*s*

The author began as a peon on an *estancia* and rose to be a manager and owner. He has also played international polo for Argentina. His reminiscences are illustrated by his own vigorous drawings.

AUSTRALASIA AND PACIFIC

THE CYCLIC LAND-SURFACES OF AUSTRALIA: a geomorphological summary

By Lester King. (*Proc. R. Soc. Victoria*, 62 (1950) 79–95)

RECENT AND PLEISTOCENE CORAL REEFS OF AUSTRALIA

By Rhodes W. Fairbridge. (*Journ. of Geol.*, 58 (1950) 330–401; maps and illustrations)

THRUST STRUCTURES OF THE WITCHELINA AREA, SOUTH AUSTRALIA

By R. C. Sprigg. (*Trans. R. Soc. South Australia*, 73 (1949) 40–47; map and illustrations)

SECONDARY INDUSTRIES IN SOUTH AUSTRALIA: recent employment trends, 1933–48

By R. Hirst. (*Proc. R.G.S. South Australia*, 50 (1949) 47–60)

LATE QUATERNARY CHANGES OF SEA-LEVEL AT ROTTNEST ISLAND, WESTERN AUSTRALIA

By Curt Teichert. (*Proc. R. Soc. Victoria*, 59 (1950) 63–79; illustrations and sketch-maps)

ANATOMY OF PARADISE: Hawaii and the islands of the South Seas

By J. C. Furnas. 8½×5½. 542 pp. *London: Victor Gollancz*, 1950. 18*s*

This book, issued in co-operation with the American Institute of Pacific Relations, deals with present and past contacts between Europeans and the native peoples, and the problems which they present to-day. The author advocates international guardianship for all the islands.

WHALE HUNT: the narrative of a voyage by Nelson Cole Haley, harpooner in the ship *Charles W. Morgan*, 1849–53. 8½×5½. 320 pp. Illustrations. *London: Robert Hale*, 1950. 15*s*

This narrative was written in Hawaii about 1864, and has not previously been published. It gives a vivid picture of life on a New Bedford whaler in the S.W. Pacific.

THE DESOLATE ANTARCTIC

By Admiral Lord Mountevans. 8½×5½. xvi+172 pp. Map and illustrations. *London: Lutterworth Press*, 1950. 12*s* 6*d*

This is not a comprehensive history of the Antarctic, but rather a commentary on Antarctic exploration and certain expeditions by "a sailor-explorer who believes in adventure, youth and duty."

NEPHELINE, SYENITE AND IRON ORE DEPOSITS IN GREENLAND

By R. Bogvad. (*Arctic*, 3 (1950) 86–94; illustrations)

GENERAL

DATING THE PAST: an introduction to geochronology

By F. E. Zeuner. 2nd ed. revised. 8½×5½. xviii+474 pp. Maps, diagrams and illustrations. *London: Methuen*, 1950. 30*s*

The first edition was reviewed at length in the *Geogr. Journ.*, 108 (1946) 227.

ON THE INFLUENCE OF THE WORLD'S OROGRAPHY ON THE GENERAL CHARACTER OF THE WESTERLIES

By B. Bolin. (*Tellus*, 2 (1950) 184–95)

DAS SYSTEM DER KLIMATISCHEN MORPHOLOGIE

By Julius Büdel. (From *Deut. Geographentag, München*, 1948, Bd. 27, 65–100; maps)

THE RESPONSE OF PLANTS TO CLIMATE

By F. W. Went. (*Science*, 112 (1950) 489–94; illustrations)

CASTE: a comparative study

By A. M. Hocart. 8½×5½. xvi+157 pp. *London: Methuen*, 1950. 15*s*

FUNDAMENTALS OF ECONOMIC GEOGRAPHY

By Nels A. Bengtson and W. van Royen. 3rd ed. (*Prentice Hall Geography series.*) 10×7. xxviii+574 pp. Maps, diagrams and illustrations. *New York: Prentice Hall* (*London: Constable*), 1950. 42*s*

The aim of this textbook is to promote an "understanding of the resources at

man's disposal and the natural conditions under which their utilization may be achieved." The first section deals with the general aspects of the earth's surface, the second with the major climatic regions and their productivity in general, and the third with mineral resources. The text is free of statistics, which are summarized in diagrams.

WEALTH OF COLONIES. The Marshall Lectures, 1950
By W. K. Hancock. 7½×4½. 82 pp. *Cambridge: Univ. Press*, 1950. 7*s* 6*d*

PEOPLES AND COUNTRIES OF THE WORLD
By Leonard Brooks and Robert Finch. (*Golden Hind Geographies*, 2nd ser., Bk. 4.) 7¾×5. 416 pp. Maps and illustrations. *London: Univ. of London Press*, 1950. 7*s* 6*d*

A PROGRESS IN MOUNTAINEERING: SCOTTISH BENS TO ALPINE PEAKS
By J. H. B. Bell. 8½×5½. xii+424 pp. Maps and illustrations. *Edinburgh: Oliver and Boyd*, 1950. 25*s*

FISHING IN MANY WATERS
By James Hornell. 9½×6½. xvi+210 pp. Illustrations. *Cambridge: Univ. Press*, 1950. 30*s*

The late Mr. James Hornell had studied fisheries in many parts of the world. Here are studies of the more ingenious methods employed, including "weapons of the chase borrowed by the fishermen," trapping devices, and poison-fishing.

THE FORTUNATE TRAVELLER
By R. S. Lambert. 8½×5¼. 242 pp. Illustrations. *London: Andrew Melrose*, 1950. 15*s*

A competently written history of travel for pleasure from antiquity to the days of Thomas Cook, related to ths changing scene.

ATLASES AND MAPS

WORLD

CARTE GÉNÉRALE BATHYMÉTRIQUE DES OCÉANS. 1/10M. at the equator, sheet A II, 4 *U.S. Dollars. Monaco: International Hydrographic Bureau*, 1949

WORLD. Distribution of Poliomyelitis 1900–1950. *New York: American Geographical Society*, 1950

NORTH ATLANTIC. Atlas der Eisverhältnisse des Nordatlantischen Ozeans und Übersichtskarten der Eisverhältnisse des Nord- und Südpolargebietes. By Prof. Dr. J. Büdel. 13½×19½, 28 plates of maps, text. *Hamburg: Deutsches Hydrographisches Institut*, 1950

PATHFINDER ATLAS FOR WEST AFRICA. 8½×7, 36 plates of maps, 6 pp. text and index, *price* 3*s*. *London: Wm. Collins Sons & Co., Ltd. and Longmans, Green & Co., Ltd.*, 1950

ADMIRALTY CHARTS. 17 New Charts, 25 New Editions, 36 Large Corrections, 1 "Decca" Lattice Chart, 1 "Loran" Lattice Chart. *London: Hydrographic Dept., Admiralty*, 1950

EUROPE

WESTERN EUROPE. 1/2·5M. *Washington: National Geographic Society*, 1950

GREAT BRITAIN. Geological Survey, 1 : 63,360. England and Wales, sheets 69 Solid and 69 Drift, 141 Solid with Drift, 204 Drift, 5*s* *each sheet*; Scotland, sheet 103 Solid and 103 Drift, 7*s* *each sheet*. *London: Geological Survey*, 1949–1950

GREAT BRITAIN. Monastic Britain, 1 : 625,000, 2 sheets, 2*s* 6*d* *each sheet*. *Chessington: Ordnance Survey*, 1950

GREAT BRITAIN. Ordnance Survey. Six-inch Map, Provisional Edition on National Sheet Lines, 7 sheets, 4*s* *each sheet*; Quarter sheets, 176 sheets, 2*s* *each sheet*. 1 : 25,000, 116 sheets, 2*s* 6*d* *each sheet*. *Chessington: Ordnance Survey*, 1950

NORTHERN IRELAND. Ordnance Survey Six-inch Map, Tyrone, 5 sheets, 5*s* *each sheet*; 1 : 63,360, 5 sheets, layered and outline, 2*s* 6*d* *and* 2*s* *each sheet*; 1 : 126,720, 5 sheets, layered and outline, 2*s* 6*d* *and* 2*s* *each sheet*; Land Utilisation Survey, 1 : 63,360, 4 sheets. *Belfast: Ordnance Survey*, 1948–1950

FINLAND. Suomen Historian Kartasto. By Eino Jutikkala. 14×10, 76 plates of maps, 6 pp. text. *Helsinki: Werner Söderström*, 1949

This historical atlas is reviewed in this issue of the *Journal* (p. 115).

FRANCE. Carte de la Végétation de la France, 1 : 200,000, 2 sheets. *Toulouse: Faculté des Sciences*, 1946

POLAND. Atlas Polski. By E. Romer. Sheets 17 and 18, Klimat. *Warsaw: Topographical Survey*, 1950

SWITZERLAND. Carta automobilistica della Svizzera al 200,000. 4 sheets. *Milan: Touring Club Italiano*, 1949

SWITZERLAND. Landeskarte der Schweiz, 1 : 50,000, 3 sheets, *price Fr.2.50. Bern: Eidg. Landestopographie*, 1950

YUGOSLAVIA. Federativna Narodna Republika Jugoslavija, 1/1·5M. By Ivan Selan. *Ljubljana: Državna Založba Slovenije*, 1949

ASIA

CHINA. Economic Atlas of Szechuan. By Li-san Chow, Shich-tao Hou and Szekew Chen. $10\frac{1}{2} \times 15$, 72 plates of maps. *Canton: China Institute of Geography*, 1946

INDIA. Statistical atlas of Bombay State (Provincial Part). *Price Rs.40. Bombay: Bureau of Economics and Statistics*, 1950

INDIA. Garhwal-Himalaya Ost. By Dipl. Ing. Ernst Huber. 1 : 150,000. *Zürich: Schweizerischen Stiftung für alpine Forschungen*, 1950

NORTH BORNEO. Preliminary Plot, 1 : 50,000, 5 sheets, *2s each sheet*; Sandakan Area, 1 : 5,000, 5 sheets, *2s 6d each sheet. Teddington: Directorate of Colonial Surveys*, 1950

AFRICA

CONGO. Atlas du Katanga Fascicule 4. 14×18, 10 maps, 15 pp. text, 8 pp. illustrations. *Brussels: Comité Spécial du Katanga*, 1950

KENYA. Preliminary Plot, 1 : 50,000, 19 sheets, *2s or 2s 6d each sheet. Teddington: Directorate of Colonial Surveys*, 1950

NIGERIA. 1/3M, Agricultural Products, Forest and Game Reserves, Geological, Languages and Dialects, Physical, Rainfall, *1s 6d each*; 1/2M, 1 sheet, *2s 6d*; 1/M, 4 sheets; 1 : 500,000, 15 sheets, *2s 6d each sheet*; Provincial Maps, 1 : 500,000, Bauchi, Calabar, Katsina, Warri, *2s 6d each*; Divisional Maps, 1 : 250,000, Bamenda, Mamfe, *3s each*; Standard Sheets, 1 : 125,000, 24 sheets, *2s each sheet*; 1 : 62,500, 9 sheets; Town Plans, 1 : 12,500, 18 sheets, *3s each sheet. Lagos: Survey Dept.*, 1948–1949

NYASALAND. Preliminary Plot, 1 : 50,000, 9 sheets, *2s each sheet. Teddington: Directorate of Colonial Surveys*, 1950

SIERRA LEONE. 1 : 62,500, 13 sheets; 1 : 250,000, 5 sheets; 1 : 1,250, Bo, 3 sheets, Freetown, 5 sheets. *Freetown: Survey and Lands Dept.*, 1942–1948

SOMALILAND. Croquis de la Côte Française des Somalis au $100{,}000^{e}$. 10 sheets. *Paris: Institut Géographique National*, 1947

SOUTH AFRICA. 1 : 500,000, 5 sheets, topographical and aeronautical editions, *2s 6d each sheet*; Southwest Africa, 1 : 800,000, 4 sheets, *32s. Pretoria: Trigonometrical Survey*, 1950

SOUTH AFRICA. Geological Survey, 1 : 125,000, sheets 46 and 166, *5s each sheet including text. Pretoria: Dept. of Mines*, 1948

TANGANYIKA. 1 : 125,000, 1 sheet; 1 : 250,000, 2 sheets, *5s each sheet. Dar-es-Salaam: Dept. of Surveys and Town Planning*, 1950

TANGANYIKA. Preliminary Plot, 1 : 50,000, 4 sheets, *2s each sheet. Teddington: Directorate of Colonial Surveys*, 1950

AMERICA

CANADA. National Topographic Series, 1 : 50,000, 11 sheets; 1 : 63,360, 26 sheets; 1 : 126,720, 5 sheets; 1 : 250,000, 1 sheet; 1 : 253,440, 11 sheets; 1 : 506,880, 14 sheets; 1/M. ICAO Aeronautical Chart, 3 sheets, *25 cents each sheet. Ottawa: Dept. of Mines and Resources*, 1948–1950

UNITED STATES. The Fry and Jefferson Map of Virginia and Maryland. Facsimile of the first edition with introduction by Dumas Malone. *97s 6d. Princeton: University Press* (*London: Geoffrey Cumberlege*), 1950

UNITED STATES. Transportation Maps, 1 : 250,000, Nevada, 15 sheets, Ohio 6 sheets, $4.50 *each. Washington: Bureau of Public Roads*, 1947–1949

UNITED STATES. Topographic sheets, 1 : 24,000, 173 sheets; 1 : 30,000, 1 sheet; 1 : 31,680, 2 sheets; 1 : 62,500, 46 sheets. *Washington: U.S. Geological Survey*, 1950

SOUTH AMERICA. 1/M, 7 sheets. *New York: American Geographical Society*, 1948–1949

These are revised editions of the sheets Rio–Mira–Islas Galapagos, Cayenne Quito, Iquitos, Para, Teresina, Paraiba

SOUTH AMERICA. Latin America. Map Review 118, *price* 1s 6*d*. *London: Bureau of Current Affairs*, 1950

AUSTRALASIA AND PACIFIC

AUSTRALIA. 1 : 63,360, 1 sheet. *Melbourne: Survey Directorate*, 1950

AUSTRALIA. Aeronautical Map, 1/1M. 13 sheets. *Canberra: Dept. of the Interior*, 1950

NEW ZEALAND. The Tararua Mountain System, 1 : 100,000. *Wellington: Lands and Survey Dept.*, 1950

TAHITI. Carte Provisoire, 1 : 100,000. *Paris: Institut Géographique National*, 1950

MEETINGS: SESSION 1950–51

Second Meeting, 30 October 1950

Films: Caribbean journeys. Colour films with a commentary by Mrs. Helweg-Larsen

Third Meeting, 13 November 1950. Professor Dudley Stamp in the Chair

Paper: The geography of determinism. By O. H. K. Spate

Fourth Meeting, 16 November 1950. Mr. Leonard Brooks in the Chair

Films: Educational films with an introduction by Miss M. C. Simpson and G. J. Cons

Fifth Meeting, 20 November 1950. The President in the Chair

Elections to Fellowship: Brian Warren Adams, B.SC.; John D. Adshead, B.A.; Sayyid M. Ahmad; Rev. Joseph H. Allen; George Bell Barker; George David Bradley; William K. Calvert; Lieutenant Peter Court, R.N.V.R.; Miss Alice M. Cree; Roger Meaden Downes, M.C.; Alan R. A. Giles; B. E. de St. P. Gotch; Geoffrey T. Harris; David T. D. Hughes; A. W. Jackman; Alfred G. E. Jones, B. COMM.; Captain H. I. K. Jones; D. B. Kapuwatte; William L. Kaye; Miss Queenie Lethbridge; Oswald D. Macnamara; John P. Matthews; Ronald Mitchell; Graham Neale, B.SC.; Edward J. S. Parsons, B.LITT., M.A.; J. C. M. Pritchard; Miss E. M. Ralfs, B.A.; Kenneth C. Riley, B.A.; Lady Gladys Mary Roberts; Cyril Edward Roe; Major Frederick A. Rowley; Joseph P. Short, B.A.; David Lloyd Thomas; Geoffrey K. Thorne; Commander R. H. Thornton, R.N.; Miss Barbara Toy; Jack E. Waltham, B.SC.; Rev. Reginald H. Warmoll; Melvin O. Watterson, M.A.; L. G. West; Rev. George Ernest Williams

Elections to Associate Membership: C. Burton; Miss Elisabeth A. Coningsby; John William Green; Miss J. Ann Harnaman; Miss Beryl M. Hayward; David M. Lang; Murison Forrest Robertson; Miss Mary Ann Steel; Miss Jean M. Stubbington; David B. Swinbank; Norman A. Tappin; Howard G. Williams; Miss Ruth A. Wood

Paper: An expedition to the Shira plateau of Kilimanjaro. By G. Salt

Sixth Meeting, 4 December 1950. Mr. R. W. Steel in the Chair

Paper: Erosion and population problems in the Eastern Provinces, Nigeria. By A. T. Grove

Seventh Meeting, 11 December 1950

Films: The Western Highlands. Colour films with a commentary by F. R. Newens

P E R S I A N

G U L F

U B A L K H A L I

Sharja
Dibai
Abu Dhabi
Sir Abu Nu'air
Zirku
Das
Ras Hasyan
Ras Kuntut
Ras Hanjura
Ras al Churab
Ras Laffan
Dalmah
Chaksha
Yas
Khaur al Bazam
Zabut
Ras Lakaliya
Al Hadhara
Ras al Kahfi
Ras Qlaeshya
Ras al Sawani
Al Tarif
Sir Bani Yas
Saram
Sarug al Hadid
Ramlat Zarara
Ramlat Ruhaibah
Ramlat al Ghafa
Ramlat al Gharbaniat
Ramlat Urug
Ramlat al Hamra
Ramlat al Riga
Ramlat Araq
Ramlat Umm al Arad
Ramlat Khasfa
Ramlat Qaria
Ramlat Mughshin
Ramlat Shaiba
Ramlat Mishash
Ramlat Abla
Ramlat Matla
Ramlat Shaiba
Ramlat Rabdah
Ramlat Hamra
Ramlat Ruwaidah
Ramlat Ghafa
Ramlat Ghafiya
Ramlat Khafiya
Ramlat Tamarisha
Ramlat Bu Marakha
Ramlat Ghafa
Ramlat Ghafiya
Ramlat Ghafiya
Ramlat Ghafiya

SOUTH-EASTERN ARABIA

FROM TRAVERSES BY W. THESIGER 1945-50

Scale 1 : 1,250,000

10 0 10 20 30 40 50 60 Miles

Routes 1949-50 ..... earlier ..... Wells .

Regional names Ja'alan

Tribal names RASHID

Sands Salt flats (sabkha)

Heights in feet from aneroid readings

57° 58° 59° 25° 24° 23° 22° 21° 20°

GULF OF OMAN

ARABIAN SEA

GULF OF MASIRA

Masira Channel

MASIRA ISLAND

Ra's al Hadd

Ra's Jidufah

Ra's Abu Rasas

Sur

Matrah

MUSCAT

Fahal

Khaburah

Al Suhar

Al Shinas

Wudham

Suadi Is.

Jaz Jun Is.

Daimaniyat Is.

Ibri

Nazwa

Samad

Hamra

Tanuf

Izki

Bahlah

Sinaw

Ibra

Mudhaireb

Qabil

Wasit

Sur

Jabrin

Al Hamra

Tawi Hadiatha Lamsala

Maitaqa Sharaej

Umm Dhafira

Al Hata

Nusaq

Barzaman

Tawi Murra

Tawi Aqda

Tawi Shaiqab

Tawi Harian

Ghadir Balful

Tawi Markha

Umm Adailan

Qarhat Zaur

Qarhat Ma'araz

Qarhat Kizawa

Ghuarfat al Habb

Al Khaisa

Zabara

Qarhat Mitain

Saraima

Al Juaiba

Al Kara'in

Jau al Hadhib

Da'sai

Mashaf

Mahaut

Bar al Hikman

Bir al Shamal

Khalaf

Ra's Abu Rasas

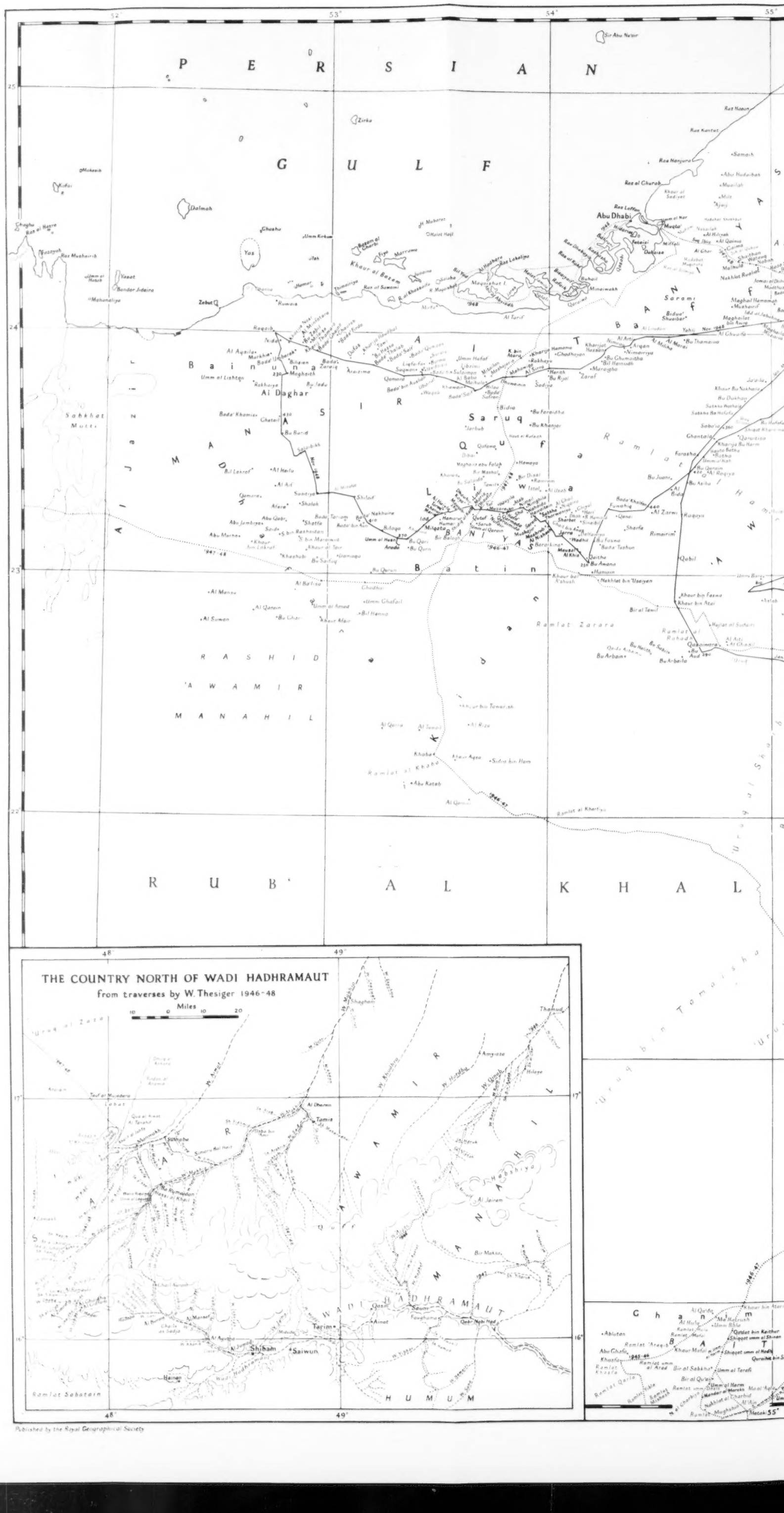
Ra's Jidufah

Ra's al Hadd

Sur

Ra's Jidufah

Ra's Abu Rasas


PERSIAN GULF
RUB' AL KHALI
Abu Dhabi
Muqta'
Mirfa
Sir Abu Nu'air
Zirku
Dalmah
Yas
Sarami
Saruq
Liwa
Baynunah
Al Dhafra
Sabkhat Matti
Ramlat Zarara
Ramlat al Khartiya
Ramlat Sabatain
Ramlat al Khabb
Ramlat al Ruhaidah
Batin
Bida Bin Saud
Bida Bin Tamaisha
Uruq bin Tamaisha
Uruq al Zafa
Uruq al Shaiba
Uruq al Shaqqa
Uruq al Mashabbih
Uruq al Mutaridah
Uruq al Ghafiyah
Uruq al Ghafa
Uruq al Ghuwaifat
Uruq al Ghuwaifah
Uruq al Ghuwaifa
Uruq al Ghuwaifa
Uruq al Ghuwaifa

SOUTH-EASTERN ARA

FROM TRAVERSES BY W. THESIGER

Scale 1 : 1,250,000

10 0 10 20 30 40 50

Routes 1949-50 ..... earlier ..... Wells .

Regional names Ja'alan

Tribal names RASHID

Sands Salt flats (sabkha)

Heights in feet from aneroid readings

55° 56° 57° 58°

Jiddat al Harasis

Sharqiya

Ramlat al Charbanidat

Ramlat al Ghafa

Ramlat Uruq

Ras Sahma

GULF OF MASIRA

Masira Channel

Bar al Hikman

Khaburah

Matrah

MUSCAT

Nazwa

Ibri

Sharja

Dibai

Al Sohar

Al Shinas

Suadi Is.

Jaz Jun Is.

Daimaniyat Is.

Wudhum

Fahal

Tanuf

Hamra

Bahlah

Jabrin

Sinaw

Izki

Samad

Bidbid

Adam

Haima

Mahawt

Khalf

Sur

Qalhat

Barzaman

Maitaqa Sharqi

Umm Dhufira

Bu Masaikha

Al Hamar

Qal Chaidh Arana

Baraimi

Qubr Salah

Sharkhaina

Zabara

Qarhat Mitam

Ma'dhad

Sarami

Qarhat Kisama

Chuaifat al Habb

Al Khaisa

Umm Adailan

Qarhat Zaur

Jabal Akhdar

Jabal al Akhdar

Bani Riyam

Bani Hina

Bani Kilban

Bani 'Umr

Bani Hawasinah

Bani Ali

Bani Chaith

Bani Kitab

Al Bu Shams

Al Bil Khail

Khatam

Dhuwahir

Sharqiyin

Sharqiya

Masakara

Mualik

Habus

Hikman

Jalan

Ja'alan

Wahiba

Sands

Sabkha

Salt flats

Wells

Tanks

Caves

Graves

Forts

Ruins

Mosques

Tents

Camels

Goats

Sheep

Cattle

Dates

Trees

Cultivation

Irrigation

Aflaj

Falaj

Wadi

Jan-Mar 1949

Jun-Mar 1950

1945-46

Eighth Meeting, 18 December 1950. The President in the Chair

Elections to Fellowship: Samuel A. Adewusi; William John Allenby; Noel D. H. Bampton; Cyril Bates, B.A.; George W. Bennett; Jack Bucknall, B.SC.; John H. H. Callow, B.A.; Roger Cole, B.A.; Leonard John Cox; Miss Eileen Cruttenden, B.A.; Miss W. Joan Curtis; Dr. R. B. Dakeyne, D.F.C., B.A.; Ivor Davies; Mrs. Monica Mary de Muth, B.A.; James Douglas Edwards; Michael James Flint; Captain Richard Gammon, M.C.; Marc T. Greene; Lieutenant J. L. Greenwood, R.N.; Eric A. Hardy; J. C. Hawkes, M.A., PH.D.; Ralph de K. L. Haynes; John R. James, B.A.; Professor William Q. Kennedy, F.R.S.; W. H. B. Key; Miss M. B. J. Lewis, B.A.; George Morrow; C. S. F. B. Nash; James C. Nichols, B.A.; John S. Probert; Guy E. King-Reynolds, M.A.; Kenneth E. Shelson, B.A.; Gilbert H. Thomas, M.A.; Lieut.-Colonel Edgar H. Thompson; Francis E. Western, B.SC.; W. Westmoreland, B.A.

Transferred from Associate Membership: Anthony P. Atkinson; Miss D. M. Atkinson; J. E. Barker; G. S. Bowden; Kenneth P. Brazier; Charles W. Carson, Jnr.; Miss S. Dawson; P. S. Fowler; Miss Joan A. Hailey; K. E. Haselup; A. Davidson Hewat; Alan J. Hume; G. R. P. Lawrence; Brian Lister; Miss Barbara Missen; G. E. Murt; James N. Oliver; Miss Ruth P. Parfait; M. J. Scarlett; Norman Shave; R. W. Simmonds; Anthony E. Vine

Elections to Associate Membership: Geoffrey F. Bishop; Charles S. Booth; Miss Anne Crundall; Miss Constance M. Hatelie; Miss A. Barbara Hoe; Raymond Montford; Peter E. Swift

Paper: Latest explorations in British Antarctica. By V. E. Fuchs

Christmas Lectures, 28 December 1950. Prairie wings and Brumas; films with a commentary by Edward Hindle, F.R.S. 1 January 1951: A bird expedition to the Canadian Arctic; films with a commentary by Peter Scott

Ninth Meeting, 4 January 1951. The President in the Chair

Paper: Some neglected aspects of geography. By Professor Dudley Stamp. The joint annual meeting with the Geographical Association and the Institute of British Geographers

Tenth Meeting, 5 January 1951. Dr. Landsborough-Thompson in the Chair

Paper: The sensory basis of bird navigation. By G. V. T. Matthews. A joint meeting with the Institute of Navigation

THE ROYAL GEOGRAPHICAL SOCIETY

KENSINGTON GORE, LONDON, S.W.7

FELLOWSHIP AND ASSOCIATE MEMBERSHIP

The object of the Society being the Promotion and Diffusion of Geographical Knowledge, it has always welcomed to its Fellowship those anxious to further this object by their interest and support, as well as those able to take a more active part in the work of discovery and exploration.

It is provided by Chapter III, § 1, of the Bye-Laws that a candidate for admission to the Fellowship of the Society must be proposed and seconded by Fellows. Further, that a candidate is not to be considered eligible until he has attained the age of twenty-one years, unless he holds a Commission in His Majesty's Forces or is a matriculated student of a University of the United Kingdom or the Self-Governing British Dominions. Proposal forms can be obtained on application to the Director and Secretary, who will also lend if necessary a List of Fellows.

Chapter V, § 1, of the Bye-Laws provides that—

(a) Every Fellow (other than those elected under Chapter III, § 6) shall, except as provided below, be required to pay either *on Election Five pounds as Entrance Fee and Three pounds as Annual Subscription for the current year and thereafter an Annual Subscription of Three pounds due on January 1 in each year ;* or *instead of an Entrance Fee on election an enhanced Annual Subscription of Four pounds for the current and five following years, and thereafter Three pounds ;* or *a single Compounding Fee of Sixty pounds.*

For Fellows who are under the age of 25 years on election the Entrance Fee shall be reduced from Five pounds to Two pounds ; or *alternatively the enhanced Annual Subscription of Four pounds shall be payable for the current year and for two following years instead of for five.*

Fellows who are on election the wives or husbands of Fellows shall pay no Entrance Fee.

Fellows who are on election the widows or widowers of Fellows shall pay no Entrance Fee if elected within one year of the decease of husband or wife.

(b) Fellows may compound for their Annual Subscriptions at any subsequent time by a payment of £60 (sixty pounds) less £2 (two pounds) for each Annual Subscription paid in excess of five with a minimum of £20 (twenty pounds) after 25 payments.

(c) No Fellow shall be entitled to vote or to enjoy any privilege of the Society while in arrear.

Chapter IIIa of the Bye-Laws, covering the terms of Associate Membership, provides that—

1. Candidates must be not less than 17 and not more than 20 years of age. They must be recommended by a Fellow, University or School authority.

2. Subscription shall be £2 per annum without Entrance Fee.

3. On attaining the age of 21 Associate Members become eligible for Fellowship. The Entrance Fee of £2 shall be waived provided they have been Associate Members for 3 years. Otherwise Associate Membership shall cease at the age of 21.

All subscriptions are payable in advance, on the 1st of January in each year.

The privileges of a Fellow or Associate Member include admission (with one Friend) to all ordinary Meetings of the Society, and the use of the Society's House, Library, and Map-room. Each Fellow is also entitled to receive a copy of all the Society's Periodical Publications. Associate Members have the choice of receiving either *The Geographical Journal* or *The Geographical Magazine*. Associate Members may not describe themselves as F.R.G.S. and have no vote at Annual or Special General Meetings.

A pamphlet giving a brief History of the Society, with a description of its Work and Publications, its Charter and Bye-Laws, and an illustrated account of its House in Kensington Gore, can be sent to anyone interested on application to the Director and Secretary.

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